ENGINEERING AND
MINING JOURNAL

INDIANAPOLIS
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Volume 123 New York, April 30, 1927 *Number* 18

Preparedness and Manganese

MANGANESE was the topic discussed in Cleveland last week at the one-day meeting held under the joint auspices of the Ohio Section and the Iron and Steel Committee of the A.I.M.E. A full report of the session appears elsewhere in this issue. An important topic this is, especially when it is recalled that manganese is essential for making steel and that thus far we undoubtedly have not been able to develop adequate resources of high-grade manganese ore in this country. It is well that this matter be considered now in time of peace with the lessons of the recent war in mind. Moreover, it is fitting that the mining industry itself undertake the investigation through the Institute, its representative body.

Preparedness was the keynote of the meeting, according to its sponsors, and the presence of at least three army officers of high rank lent a proper coloring to the setting. But, as the program unfolded, it became evident that there was another factor—the tariff, under protection of which domestic owners and producers of manganese and manganiferous ores have been hoping—and some of them trying—to develop an adequate domestic resource at home. A forlorn hope this is, if the joint report of the Institute and the Mining and Metallurgical Society, made some years ago on manganese, be taken at its face, and if some of the assertions made by speakers at the meeting be well founded.

The tariff on manganese ore is based on the erroneous theory that the war-time production of domestic mines is indicative of their ability to supply the country's need in times of peace, according to J. V. W. Reynders, in the paper which he presented at the meeting. In 1926, moreover, Mr. Reynders said, nearly $8,000,000 was paid to the United States customs by American consumers of manganese, and at that the domestic production was only 22,400 tons of ore. In other words, the speaker said, the public at large was taxed $360 per ton of ore produced, although each ton had a sales value of only $31. The point also was well made by Mr. Reynders that where the national resources of any essential mineral are limited a protective tariff serves to put a premium on their early exhaustion.

In line, then, with the recommendations of the "Committee on Industrial Preparedness," Mr. Reynders urged that the U. S. Government should accumulate over a period of years such a stock of manganese ore of standard grade and analysis as would meet the needs of the War and Navy Departments should the national security ever be put in jeopardy. This ore must needs be foreign. The market value of such a supply, to be acquired in from six to nine years, according to the committee's recommendations, is estimated at $12,000,000. An alternative to buying this ore, said Mr. Reynders, would be to have the duty payable "in kind."

The producer or would-be producer of domestic manganese ore views the situation from a different angle. An infant industry, that of producing manganese surely is. But, the manganese miner asks, is it not for infant industries that we have the protective tariff? And why should the steel industry which has been nurtured on a protective tariff object to the comparatively insignificant amount that it must pay on manganese? the miner also queries. The total duty last year was less than 7c. per capita of the total population, which ultimately pays the bill. As for the limited extent of the manganese reserve, the domestic producer refuses to accept the reports thus far made as final. Work done since they were made has in places yielded more than was estimated to exist, and continued work, he optimistically holds, will reveal still larger tonnages. And if the government is to spend $12,000,000 in acquiring an emergency ore reserve, where will the money come from save through the tariff and taxation? Why not continue the tariff, the miner asks, and use the revenue for this purpose?

As a compromise, if a compromise ultimately be necessary, the tariff might be continued, for a time at least, and the revenue thus made available applied in part to fostering domestic manganese research to a greater extent than is possible at present, and in part to purchasing at the current market price the domestic ores, crude and beneficiated, produced, these to be stored for war emergencies. This proposal should satisfy those who contend that the limited known reserve should be kept in the ground for war contingencies. The domestic reserve would thus be equally conserved, but above ground instead of under. If, after several years, the reserve thus stored proves clearly inadequate, then and then only, resort could be made to the expedient of stocking foreign ores. If it be contended, as is likely, that such domestic product will not satisfy fully the metallurgical requirements of the furnaces, it may be answered that further research by metallurgists will probably show some way by which it may be so utilized.

Miami Makes a Record

GREAT CREDIT is due the technical staff and management of the Miami Copper Co. for the record of costs established in 1926. From a sulphide ore averaging 19.58 lb. of copper per ton—less than 1 per cent—a recovery of about 14½ lb. was made at a direct cost of 10.68c. per pound; or after allowance for miscellaneous credits, a cost of 10.62c. per pound. Mining costs, including development, were 37.1c per ton, based on 3,800,000 tons. Incidentally, in mining this large tonnage, no fatal accidents occurred underground during the year. Milling costs, involving fine grinding, were 49.1c. per ton. Mining, milling, and general expense totaled 6.93c. per pound of copper pro-

duced. Per pound costs were, in cents, as follows: Development, 0.686; mining, 1.859; milling, 3.365; general expense, 1.019; freight, 0.126; smelting, refining, and freight on pig copper, 2.973; selling expense and miscellaneous, 0.655; total, 10.684.

It is of interest to note that the engineering staff, manager, and superintendents received a total of approximately 5.1 per cent of the operating surplus. This is at the rate of 0.147c. per pound of copper produced, or $2.94 per ton of copper. Copper sold for $282.58 per ton; therefore engineers, managers, and superintendents received a little more than 1 per cent of the proceeds of sales of copper.

Apparently the tailing loss was at the rate of 4.553 lb. per ton; the smelting losses were 0.527 lb. per ton, and the total metallurgical losses 5.08 lb. per ton. Of these about 2 lb. was in the form of soluble copper and 2.55 lb. in the form of sulphide copper.

Further improvement in diminishing metallurgical losses might be secured through additional research.

As indicating the greater control over undercut caving operations, the company's report states that in completely working out two stopes, which had been carried on the books as containing 1,951,252 tons of 1.0654 per cent ore, the tonnage won was 2,364,736 tons of 0.09943 per cent ore. This gives an ore extraction of 121.2 per cent; grade extraction, 93.33 per cent; and copper recovery, 113.11 per cent. The mining of 29 tons of ore per underground worker per day is noteworthy.

Automobile Production Declining

THE AUTOMOTIVE INDUSTRY has come to be so important in the United States, and such a large consumer of metals, that its prosperity and data on its production are of interest to every one. Department of Commerce figures issued last week show that the production of passenger cars so far this year has been considerably below that of a year ago. In January, 1927, output was 28 per cent less than in January, 1926; the February output 18½ per cent less; and the March output of 341,665 passenger cars was 10 per cent less than in March of last year. Manufacture of trucks during the first quarter, however, shows a slight increase, but as the number of trucks made is only 15 per cent of the number of passenger cars, the increase is comparatively unimportant.

Some automobile companies—Chevrolet for instance—are making new records this year, but they are doing so at the expense of others. Although the saturation point in the automobile industry in the United States has by no means been reached, there is ample evidence that the rapid acceleration in the rate of production that has characterized recent years has been effectively checked; and this at a time when prosperity continues great, money plentiful, and long-term financing of car purchases easily accomplished. Of course, there will always be a big demand for new cars by the oncoming generation and by present owners as their old ones wear out. This is certain in a country where 22,000,000 cars are registered—about one for every five inhabitants. But for undeveloped sales territory, manufacturers must look more and more abroad. There the potential demand is enormous; though unfortunately the wherewithal to buy is decidedly limited.

Sellers of lead have felt the decreased demand for automobiles through the corresponding shrinkage in the market for storage batteries. The battery makers have taken much less lead than was expected, and as one-fifth of all the lead produced goes into batteries, the loss of much of this trade is keenly felt. Aluminum is another metal that enters into automobile construction in an important way, and well over 100,000 tons of copper is used by automobile manufacturers in the United States each year.

America's Unofficial Ambassadors

FROM OBSERVATION of the conduct and the attitude of the American mining engineer, metallurgist, or geologist, peoples of many foreign countries form to a large extent their conceptions of the government and citizens of the United States. These Americans for a period of months or years live among the people of the region to which they are sent. By the nature of things they become in truth unofficial representatives of America. Their attitude toward the peoples of other countries and their conduct during their sojourn—long or short—inevitably will be interpreted as reflecting the habits, ideals, and thoughts of the people of the United States.

In the selection of technical men for foreign posts of responsibility, therefore, character, personality, tact, and a degree of culture are essential qualifications as well as technical ability and professional experience. Painstaking care should be exercised in the employment of men to be sent to mining properties abroad. Much of the "grief" experienced by companies prospecting for or developing or exploiting mining properties in foreign countries is created by conduct, on the part of technical representatives, of a character which they would carefully avoid if living and working in the United States or Canada. If the restraining influences of his customary environment be lacking, the weak man is likely to indulge in habits and inhibitions which society condemns at home, on the theory that it is nobody's business "East of Suez."

Recently an inquiry came to the editorial department of *E. & M. J.* regarding the qualifications of a mining engineer who was seeking to obtain a position abroad. In his references he mentioned employment by a mining company having its headquarters in New York City, and the inquirer requested a check-up with the mining company's officials. Consultation by telephone developed the fact that the engineer had been sent to a mining property in a remote region, that he had failed to report for months, and that when the company employing him at last sent a man to find out what was wrong, the discovery was made that the engineer had failed utterly and in every particular.

Critical selection "at the source" is essential. Test for character and personality, as well as for professional and technical ability, in selecting a scout, manager, or other official for service where he will for weeks or months be out of touch with the home office, keeping in mind the fact that he is "a little bit of the United States." His conduct may be such as to heighten the esteem in which all and sundry with whom he develops business or social contacts hold the United States and its people—or to lower it.

Mining engineers possessing every essential attribute to assure successful and creditable service abroad are not lacking. Manifestly, however, they are able to demand adequate remuneration for their services. To

select as a measure of economy the unknown and untried man for foreign work is to invite loss, not alone of investment, but of what is of far greater importance—the country's prestige and good repute.

Advertising the Uses of Marble

INTENSE COMPETITION or pressure to sell has seriously affected staid commodities such as timber and stone and many other things—even the long-established metals. Times change and also points of view, as well as fashions. It is part of the psychology of some humans to do things differently and to use other materials than are customary for specific purposes. Nowhere else is this so apparent as in the United States.

It can be assumed as a maxim that no market can be maintained or expanded unless consistent effort is made to keep people thinking about the commodity in question and about its highly desirable characteristics for certain purposes. Again and again the story must be furbished and retold. It is part of present-day marketing practice.

An issue of the *Atlantic Monthly* was recently thumbed over and the advertising pages were casually studied. Attention was attracted to a page advertisement advocating the use of marble. Marble and its use in building and for architectural embellishment dates far back in history. Both Greeks and Romans were entranced with its beauty; they carved wonderful statues from it and faced their important buildings with it. Not so long ago, table tops, bureaus, and other furniture required a bit of marble to accord with the prevailing fashion. Marble mantelpieces were common at the time. However, other things displaced marble for these purposes. First the desire of the few to be different, then the desire of the many to be in fashion, relegated the old marble-top furniture into the discard. Artificial stone, a comparatively new product, now competes with marble for architectural trim and interior ornamentation, and in spite of the assertion that "there is no substitute for marble," the artificial product has become established.

Marble producers and dealers recognize the conditions and know that, to maintain a reasonable market stability, they must "sell" their product to the consumer. In this respect they are following in the footsteps of the copper producers and others in the metal and mineral industries. Closely related to mining and quarrying is the merchandising problem; it cannot be neglected.

Psychiatry and Geology

IN A CURRENT criminal court action, by a revolutionary procedure, four psychiatrists—two designated by the prosecution and two by the defense—examined the defendant with the single purpose of getting at the truth. It was agreed that both sides should be bound by the findings of the group, provided the decision were unanimous as to the sanity or insanity of the man. Working as scientists diagnosing a case rather than as partisans seeking for grounds on which to base an opinion that would promote the interests of the side paying his fees, each of the four alienists reached the same conclusion. One of the men is quoted as saying:

"For my own part, I have been actuated in this matter largely by a desire to remove a stigma from my profession—that is, to erase the popular belief that any alienist will testify any way for pay. My associates in this case were all of my opinion and joined in favoring the procedure which left us absolutely free to consider the case of ——— as if he were an ordinary patient, forgetting the position in which he stood. District attorney ——— told us to forget who had employed us and to think of nothing but getting at the truth about the man."

Here is food for thought for geologists who accept big fees for giving partisan expert testimony in mining litigation. Aside from the removal of a possible "stigma from their profession," they would doubtless prevent the waste of a lot of money, and promote the ends of justice to better purpose than they have frequently done in the past.

Iron and Steel in the Western States

IN A RECENT ADDRESS Wigginton E. Creed stated that in the producing branch of the steel business there is an investment of something like one hundred million dollars in California. Though this statement is general, the fact remains that the Western iron and steel business has made substantial progress and has finally established pig-iron production from iron ore on a commercial scale. For a long time efforts were made to initiate production, but apart from the establishment of steel plants utilizing scrap, nothing was accomplished. However, the urgent necessity for the establishment of manufacturing industries in the Pacific Coast region and the rapid development of hydro-electric power finally brought about the establishment of the existing steel industry. Diversity of production has increased and markets are expanding. A substantial foothold has been obtained.

The Colorado Fuel & Iron Co. was incorporated in 1892 in Colorado and was for many years the only commercial plant making pig iron west of St. Louis, which is at the western end of the great industrial zone of the United States. The seven Pacific states, embracing an area of 707,264 square miles and a population now around eight million, are rapidly increasing in industrial importance. It was inevitable that this basic industry should be established. Foundries and fabricating shops were long in existence, but the situation called for a more positive source of raw materials than that afforded by the scrap market and the more distant domestic sources. This came about through the foresight and courage of business men upon the Coast, who flung their hats into the steel ring. There is now a well-knit organization of the iron, steel, and allied industries in these states. Already three annual conferences have been held and the critical needs of the new industries are being studied. The policy of this organization is "to give preference to California, Pacific Coast, and American products, in the order named, on the basis of quality, service, and price." Freight-rate schedules are being closely scanned and the relatively narrow territory is being widened by readjustment of freight rates. Competition from foreign steel is being headed off and the important parts of the industry are understanding better the needs and exigencies of their business. With such unity of effort as is now apparent, the Coast industry should show a substantial growth not only in markets but also in mining iron ore and increased facilities for its reduction.

Mining and Milling *at the* Katherine Gold Mine

Cyanidation Practice Has Unusual Features
Cost Low for Such a Remote Property

By R. L. Dimmick and Eugene Ireland
Manager and Mill Superintendent, respectively, Katherine Gold Mining Co., Kingman, Ariz.

MUCH INTEREST has been aroused recently, particularly in the Southwest, in the reopening and successful operation of a property whose history dates back some twenty-five years—the Katherine gold mine, in the San Francisco mining district of northwestern Arizona. So much has been published that is inaccurate and misleading that the present seems a propitious time for an authoritative article.

When the mine was first opened a 400-ft. shaft was sunk with lateral work at 100-ft. intervals. Considerable stoping was done, the ore being treated in the old Sheeptrail stamp mill on the Colorado River below the mine. Wagon transportation was expensive and the amalgamation process used was not particularly efficient, so that little profit was made even on $12 ore, and operations were suspended in 1906. In 1919 active exploration was resumed by the original company, the Katherine Gold Mining Co., of Delaware, which resulted in developing a large low-grade gold mine.

As already mentioned, the mine is in the San Francisco district of Mohave County, Ariz. Thirty-three miles to the east is Kingman, the county seat and nearest railway point on the main line of the Santa Fé. About twelve miles south of the mine is the well-known town of Oatman, and a mile and a half to the west is the Colorado River. The elevation of the mine is 996 ft. above sea level.

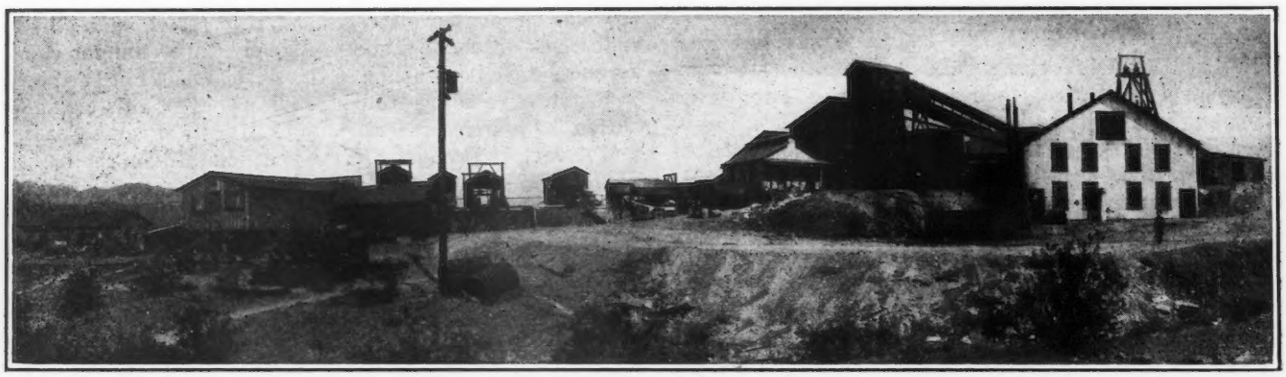
Geological Aspects Easily Determined

The geology of the deposit is simple. The vein occurs in the midst of a large and fairly uniform area of Pre-Cambrian granite, the granite being largely buried under débris. To the southeast, at higher elevation, andesite, porphyry, and rhyolite flows are in evidence, though to the west erosion has removed all signs of these flows. The andesites are frequently consolidated breccias, and sometimes amygdaloidal. They are cut by later rhyolite dikes.

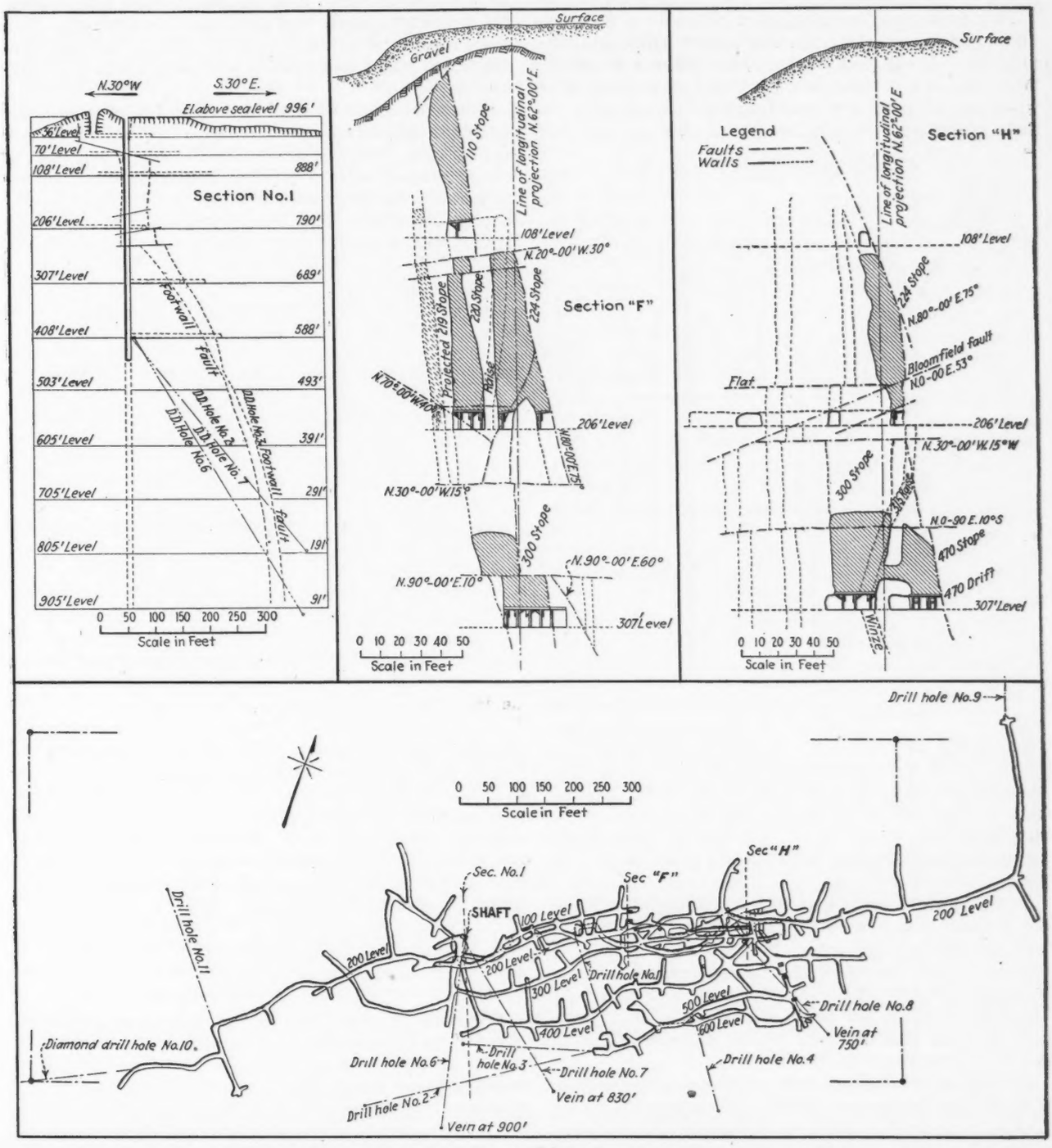
Gold Finely Distributed Through Quartz

The lode was evidently formed in stages. First, seams and layers of a white and glassy variety of quartz were deposited, with silicification of the intervening rock. This variety of quartz carries little gold and practically never constitutes commercial ore. In the second stage, seams and large lenses of crystallized calcite were deposited locally in the vein. Not much of this calcite remains, for in the third stage it was largely replaced by quartz of a pale greenish tint that retains the internal structure of the calcite. Compared with the veins in the Oatman district, the Katherine vein contains much less calcite. The greenish quartz is at times traversed by narrow wavy bands of ribbon quartz, layers of a greenish-yellow waxy appearance alternating with layers of white quartz. It is this aggregate of greenish quartz, ribbon seams, and remnants of the coarse crystallized calcite stained dark by manganese dioxide that constitutes the ore. The occurrence is well understood by all who have been familiar with the ore in the Tom Reed and the United Eastern mines. The gold is finely distributed throughout the quartz, and the vein is remarkably free from other minerals. A fine sprinkling of pyrite has been observed in the fracture planes in adjacent or included masses of country rock, but, in general, sulphides are entirely absent.

Pronounced faulting is a general characteristic, most of the faults being thrust faults dipping gently to the westward. Except for complicating the estimating of



Surface plant of the Katherine Gold mine. The shaft and the power house are shown at right, adjacent to the mill



To the left, above, is Section No. 1, N. 30 deg. W., through the Katherine shaft. In the middle is a cross-section of the mine at "F," and to the right, at "H." Below, is a map showing the workings at various levels

the ore reserves and adding to the difficulties of directing the exploration work, the faults give no trouble, though they are, of course, annoying. The geological problems are in the hands of Ira B. Joralemon.

The irregular Katherine vein, of quartz and calcite cutting granite, follows a fracture zone which strikes N. 55 deg. E., and dips 80 deg. or more northwest. The total width of the fractured shear zone is more than 260 ft. Away from the oreshoots, the mineralization is confined to narrow streaks of crystalline quartz along the fractures in iron-stained, altered granite. In and near oreshoots, the proportion of quartz to granite increases until there are bands of nearly solid quartz up to 60 ft. or more in width. Much of this gold-bearing quartz has replaced the earlier calcite mineralization referred to before, though some calcite remains unreplaced. Even in the heart of the orebodies there is much altered granite. The steep banding of the vein material is everywhere apparent. Although some of the bands have filled open fissures, much of the vein material has probably replaced the altered granite of the fracture zone.

Intersecting faults have broken the vein into many irregular fault blocks. The faulting is apparently all due to a prolonged pressure, from below and from the south. Often the ore is found crushed into a breccia

in which none of the original vein structure remains.

Two methods of stoping were adopted: a slice-and-fill and shrinkage stope, the last named being the usual practice. A sill floor of 10x10-in. timbers is carried where the vein is more than 15 ft. and up to 40 or 50 ft. wide, and all posts are head-boarded against stulls for their protection. Several times this style of stope has been carried over a length of 700 ft., with a vertical height of 200 ft. The slice-and-fill stope is resorted to wherever the hanging wall is weak, fill being obtained from the footwall material. In the width of the shear zone developed, four strands of ore have been found, varying in width from 9 to 60 ft. over a length of from 600 to 1,700 ft.

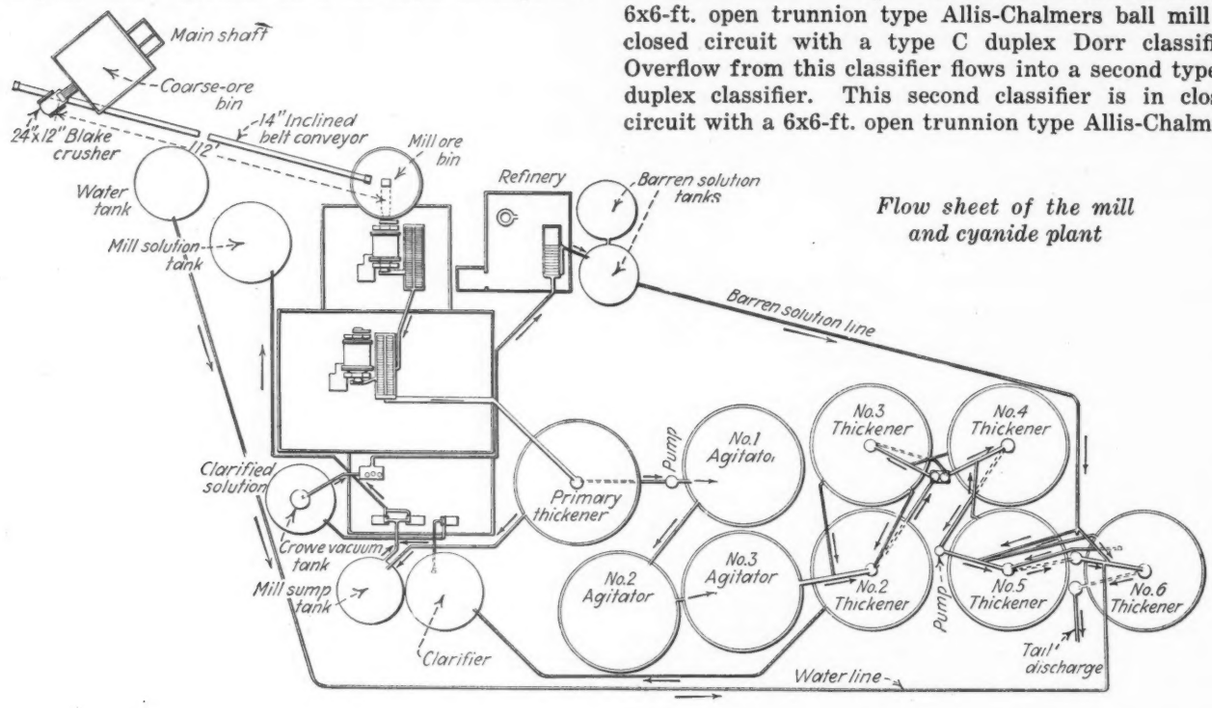
The main workings are from the 400 level to surface, but a winze was sunk to the 600 level, and diamond drills cut to the 1,000, where the vein was located. In February, 1927, the main three-compartment shaft was being put down to the level of the deepest drill hole. Although workings are below the Colorado River level, there is little trouble from water, the average being 40 gal. per minute at the 600 level.

The cost of mining this type of orebody ranges from $1.50 per ton shrinkage to $2.25 on filled stopes.

Electric power is generated on the ground by direct-connected Diesel engines, there being installed two 360-hp. Fairbanks Morse, one 200-hp. De La Vergne, and one 200-hp. Chicago Pneumatic. This combination allows for a complete stand-by unit, records covering the last eighteen months' operation showing 98 per cent operating time. Three-phase, 60-cycle current is supplied from the generators to all sections of the mine and mill at 440 volts. Its cost should be of interest to remote properties. This amounts to 1.718c. per kilowatt-hour, including taxes. Fuel oil, of 24 deg. Bé. gravity delivered by auto trucks, costs 8c. per gallon at the plant and from 10 to 11½ kw.-hr. is delivered per gallon of fuel.

Run-of-mine ore, which will pass an 8-in. grizzly, is hoisted in skips to a 100-ton bin. This bin discharges over a bar grizzly, with 1½-in. spaces and inclined at 37 deg. to a 24x12-in. Allis-Chalmers Blake type crusher set to deliver a 2½-in. ring product. The discharge from the grizzly and crusher falls on a 14-in. inclined conveyor belt which delivers ore to a 150-ton silo type mill-ore bin.

From the center of the bin bottom, ore runs on to an 18-in. ratchet-driven apron feeder and is delivered to a 6x6-ft. open trunnion type Allis-Chalmers ball mill in closed circuit with a type C duplex Dorr classifier. Overflow from this classifier flows into a second type C duplex classifier. This second classifier is in closed circuit with a 6x6-ft. open trunnion type Allis-Chalmers Ball-Peb mill. Overflow from this classifier flows to the primary thickener of the cyanide plant.



Flow sheet of the mill and cyanide plant

Each mill is direct-driven through Wuest gears by a 125-hp. slip-ring motor, about 85 to 90 hp. being required to drive each mill. Five-inch forged-steel balls are used in the primary mill and 2½-in. in the secondary, or Ball-Peb mill. The average screen analysis of the second classifier overflow is:

	Per Cent
+ 80 mesh	17
+ 100 mesh	6
+ 150 mesh	10
+ 200 mesh	10
— 200 mesh	57

Grinding 260 tons per day to this mesh consumes about 2 lb. of balls per ton of ore in the primary and 2.2 lb. in the secondary. A feature of the grinding, showing the rapid settling properties of the ore, is that dilution in the secondary classifier is only 2.3 to 1.

The primary thickener is a 30x10-ft. Dorr. Overflow runs to the mill sump tanks and is used as mill solution. The thickened pulp is pumped by a No. 4 Dorrco suction pump to the first of a series of three 28x14-ft. Dorr agitators. Agitation is continuous. No. 3 agitator overflows into the first and second thickeners of the counter-current decantation system, about 15 per cent going to the second thickener and 85 per cent to the first. The object is to lighten the load on the first thickener so as to be sure of having a clear overflow at all times.

The decantation system consists of five thickeners, four 28x10-ft. Dorr and one 28x10-ft. Hardinge Super-thickener. The Hardinge thickener is the last in the series. As in standard C. C. D. plants, the thickened pulp is pumped by No. 4 Dorrco suction pumps from one thickener to the next, and finally out of the super-

thickener to the tailing pond. Water wash and one-half of the barren solution wash go into the last thickener, the other half of the barren solution going into the next to the last thickener. The tanks are stepped, enabling the solution to flow by gravity back through all thickeners to the thickener immediately following the agitators, from which it goes to a Hardinge clarifier. The filtrate from this clarifier goes to the precipitation department. Excess solution overflows the clarifier into the mill sump tank, where it unites with overflow from the primary thickener and is used as mill solution.

The precipitation department consists of standard Crowe vacuum equipment with a Merrill zinc-dust feeder and a 36-in., twenty-frame Merrill precipitation press. This press is dressed with four layers of Pequot sheeting. At each clean-up the top sheet is removed and burned, a new sheet being placed next to the frame.

The mill and cyanide plant were originally designed to treat 150 tons per day, grinding to about 80 per cent minus-200 mesh. It was soon found that coarser grinding would give satisfactory extraction, enabling the plant to be stepped up to 260 tons per day, the present tonnage. The problem then was to treat the increased tonnage in the cyanide plant. During the summer, when solutions average about 88 deg. F., the Dorr thickeners would handle 210 tons per day discharging at 45 to 50 per cent solids. During the winter, when solutions average about 55 deg., the discharges had to be kept at 40 to 45 per cent solids. The curves on page 720 show the theoretical capacities of these tanks, figured by the Coe-Clevenger formula, and tied into actual plant results. These showed that insufficient washing would result. Originally the C. C. D. system consisted of only four thickeners. To it was added the 28x10-ft. Hardinge Super-thickener, which successfully met the difficulty, the Super-thickener discharge at about 65 per cent solids cutting the cyanide and water consumption about 50 per cent and making an equal saving in reducing the dissolved gold loss.

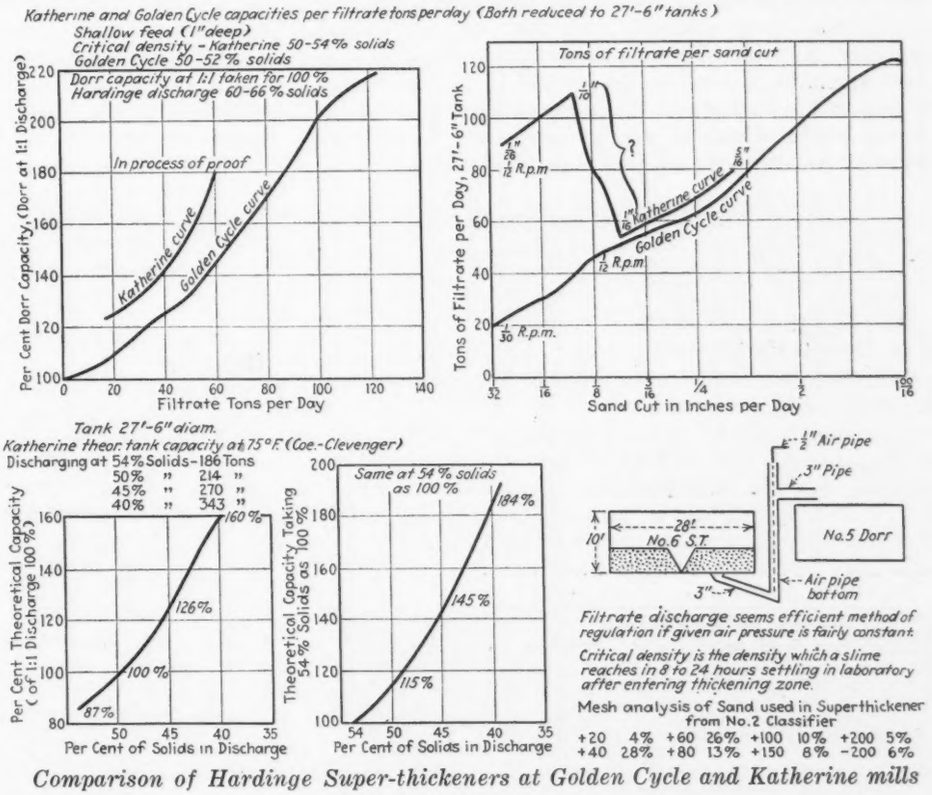
The following notes on the construction and operation of this thickener may be of interest: A standard false bottom as used in leaching vats was installed in the tank. On this was laid a 3-ft. bed of sand by pumping into the tank, with a 2-in. Wilfley sand pump, the secondary classifier sand, the mechanism revolving at the same time. A perfect bed was formed in this manner. The machine operates at $\frac{1}{12}$ r.p.m., making a sand cut of 1/26 in. per day. This is the smallest cut the present mechanism will allow.

The charge is fed into the center well about 2 ft. deep. About fifty tons of solution per day is taken through the filter bottom and discharged by air lift into No. 5 thickener, overflow also flowing to this thickener, A No. 4 Dorrco suction pump discharges thickened pulp at 65 per cent solids. It is necessary to add water to this pulp to carry it to the tailing pond through a pipe inclined at about 40 deg.

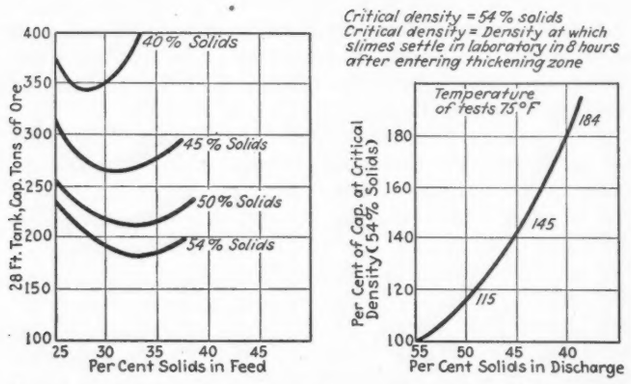
At present (February, 1927) the machine has been in operation for about six months under the above-described conditions. Mine development shows that a larger plant will be needed, so with this in view experiments are now under way to determine the capacity of the machine, what effect deeper feeding would have, correct filtrate discharge, and minimum sand cut. With the coarse feed which the thickener is getting, it has been found necessary to throttle the filtrate discharge to keep sufficient slime in the tank to mix with the sand.

Standard practice in a C. C. D. plant treating gold ores is to use the overflow from the primary thickener as gold solution, and the overflow from No. 2, or the first thickener following the agitators, as mill solution. The reverse is being practiced in this plant. This was made necessary by clarification difficulties. Originally, when treating small tonnages, a pressure leaf filter was used for clarification; when the tonnage was increased this was found inadequate, probably owing to chemical precipitation, and a 20x8-ft. Hardinge clarifier was installed. This is practically a duplicate of the Super-thickener, the same sand being used for the filter bottom in each instance with the exception that for the clarifier the sand was washed with 1 to 1 solution.

When the solutions from the primary thickener were clarified a hard impervious sand cake soon formed on the filter medium. This was undoubtedly due to calcium sulphate in the solution cementing the sand. This condition was corrected by clarifying the overflow from No. 2 thickener, the calcium sulphate evidently being precipitated out in the pulp during its passage through the agitator. Further proof that this assumption is correct is shown by the fact that the sand bottom in


Katherine and Golden Cycle capacities per filtrate tons per day (Both reduced to 27'-6" tanks)
Shallow feed (1" deep)
Critical density - Katherine 50-54% solids
Golden Cycle 50-52% solids
Dorr capacity at 1:1 taken for 100%
Hardinge discharge 60-66% solids
In process of proof
Katherine curve
Golden Cycle curve
Per Cent Dorr Capacity (Dorr at 1:1 Discharge)
Filtrate Tons per Day
Tons of filtrate per sand cut
Tons of Filtrate per Day, 27'-6" Tank
Katherine curve
Golden Cycle curve
Sand Cut in Inches per Day
Tank 27'-6" diam.
Katherine theor. tank capacity at 75° F. (Coe.-Clevenger)
Discharging at 54% Solids - 186 Tons
50% " 214 "
45% " 270 "
40% " 343 "
Per Cent Theoretical Capacity (of 1:1 Discharge 100%)
Per Cent of Solids in Discharge
Same at 54% solids as 100%
Theoretical Capacity Taking 54% Solids as 100%
Per Cent of Solids in Discharge
3" Pipe
No. 6 S.T.
No. 5 Dorr
Air pipe bottom
Filtrate discharge seems efficient method of regulation if given air pressure is fairly constant.
Critical density is the density which a slime reaches in 8 to 24 hours settling in laboratory after entering thickening zone.
Mesh analysis of Sand used in Superthickener from No. 2 Classifier
+20 4% +60 26% +100 10% +200 5%
+40 28% +80 13% +150 8% -200 6%

Comparison of Hardinge Super-thickeners at Golden Cycle and Katherine mills


Critical density = 54 % solids
Critical density = Density at which slimes settle in laboratory in 8 hours after entering thickening zone
40 % Solids
45 % Solids
50 % Solids
54 % Solids
28 Ft. Tank, Cap. Tons of Ore
Per Cent Solids in Feed
Temperature of tests 75° F
184
145
115
Per Cent of Cap. at Critical Density (54 % Solids)
Per Cent Solids in Discharge

Curves showing theoretical capacities of 28-ft. Dorr tanks at Katherine mill, by Coe-Clevenger formula

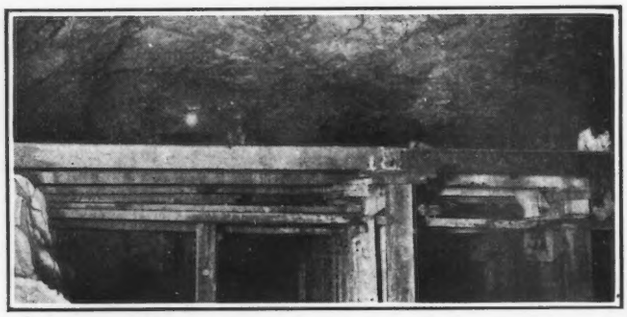
the Super-thickener has never shown the least tendency to harden during six months' operation. Since making the change the clarifier has worked satisfactorily, a ½-in. sand cut per day being required to keep the filter bottom open.

The improvement in clarification had a marked effect on the product in the precipitation press. With the standard Crowe vacuum system used, the zinc consumption per ton of solution is about 0.09 lb. Approximately equal amounts of gold and silver are precipitated, though there is slightly more silver than gold. The press product is fed wet into a DFC tilting furnace; and this product, exclusive of moisture, will average 850 to 900 fine in gold and silver. Bullion produced is about 950 to 960 fine. The extreme purity of the product is due to chemical consumption of the zinc not only by cyanide but evidently sodium and potassium hydroxide as well. These hydrates, as well as the calcium sulphate, are evidently formed by the action of calcium oxide on salts in the mine water used for milling and salts dissolved out of the ore. Analysis of the mine water shows, in grains per gallon:

$CaCO_3$	5.158
$CaSO_4$	4.119
Na_2SO_4, K_2SO_4	6.387
NaCl, KCl	15.980

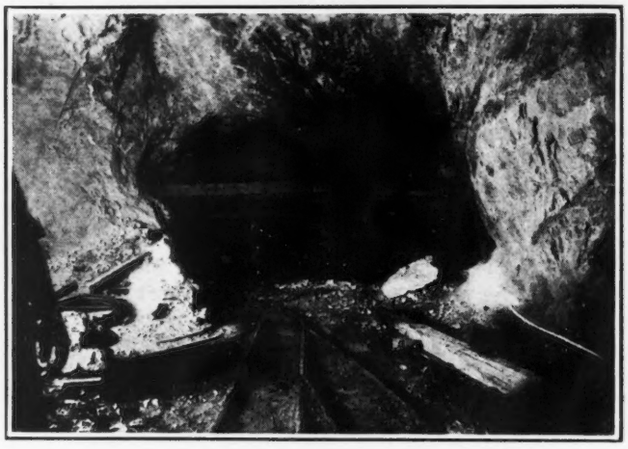
Probably the salts dissolved from the ore have more effect than the mine water alone.

The zinc dust used is the finest grained obtainable. A coarser dust was tried out in an endeavor to stop some of the dissolution of the zinc, but precipitation was so erratic that this was discontinued. Precipitation efficiency is about 99.90 per cent. A further feature of this plant is that no lead acetate or litharge is required. Repeated tests have shown that precipitation is as good without as with the use of these lead salts.



Method of timbering sill floor where the vein is wide

Using overflow from the primary thickener as mill solution instead of as gold solution would ordinarily cause a high tie-up of gold in most plants. Here, however, it does not occur to any appreciable extent, owing to the fact that only about 35 to 40 per cent of the extraction takes place in the grinding circuit, the three 28x14-ft. Dorr agitators proving able to complete the extraction. Some doubt was expressed as to the ability of these agitators to handle such coarse feed at 45 per cent solids, but in the eighteen months that these machines, as well as the thickeners, have been in operation not a minute's time has been lost for repairs. Credit for this continuous operation, however, must be given



A 50-ft. stope width on the 300 level

to a large extent to the power plant, power being supplied with practically no interruptions.

As above stated, the barren solution wash is being added half to No. 5 and half to No. 6 thickeners. This can be done owing to the low cyanide strength required. An average of 75 lb. of Aero brand cyanide (equivalent to 37 lb. of NaCN) is consumed per day. The cyanide strength in the agitators is kept at 0.7 lb. NaCN per ton of solution, and protective alkalinity at 0.9 lb. CaO. The gold solution titrates 0.6 lb. NaCN and 1.0 lb. CaO per ton.

Consumption of Principal Supplies, and Costs

	Per Ton of Ore
Power, kw.-hr.	16.0
5-in. balls, lb.	2.0
2½-in. balls, lb.	2.2
Lime, lb.	3.0
Cyanide (NaCN), lb.	0.16
Water, tons	0.62
Zinc dust, per ton solution, lb.	0.070

Cost per Ton of Ore

Supplies	$0.462
Labor	.359
Power	.291
Total	$1.112

Total Cost of Operation

Including all charges but depreciation

	Per ton ore
General expense	$0.59
Mill operation	1.11
Mine operation	1.63
Mine development	0.62
Total	$3.95

The tailing loss averages about 15c. per ton of ore, undissolved, and 4.5c., dissolved.

Construction of the mill started Jan. 1, 1925, and it was put in operation June 29 of that year. Total construction cost as the mill stands today is $95,000, or

$365 per ton of capacity. The mill and cyanide plant was designed and erected by Eugene Ireland, present mill superintendent, under direct supervision of R. L. Dimmick, manager. Charles Sutro, of San Francisco, is president of the company; R. L. Dimmick, of Kingman, Ariz., vice-president; Julius I. Cahn, San Francisco, secretary; and the Anglo-California Trust Co., San Francisco, treasurer. Directors include Charles Sutro, R. L. Dimmick, Ben W. Vallett, A. L. Bloomfield, and Allen E. Ware.

Carving a Heroic Memorial on a Granite Mountain

AN unusual combination of the artistic and the utilitarian is found in the activities around the famous Stone Mountain near Atlanta, Ga. Besides operating its large granite quarries, the Stone Mountain Granite Corporation, as contractor, is engaged on what is probably the greatest sculptural undertaking in the world's history, the carving of the Stone Mountain Confederate Memorial. Since work was started on Aug. 25, 1926, more than 500,000 cu.ft. of rock has been blasted away to prepare the vertical face necessary for carving the heroic figures that are to form the central panel of the memorial. The accompanying illustration shows the group composed of Jefferson Davis, Robert E. Lee, and Stonewall Jackson. The figures are to be 125 ft. in height.

To prepare the face, holes averaging 20 ft. deep spaced 4 ft. apart were drilled. After springing with dynamite these were loaded with black powder and dynamite and the group of holes was fired in a single volley. For this work a special compressor plant and sharpening shop, equipped with oil-fired furnaces and pneumatic drill sharpeners, are provided.

Stone Mountain is an outstanding geological feature of the eastern terrain. It is a great boss of rock 1½ miles long and ¾ mile wide and rises 650 ft. above the upland at its base. It is a typical granite dome. Lawrence La Forge says that "It owes its shape to the process of weathering known as exfoliation; the sides are so steep and the top is so well rounded that loose material formed by slow breaking down of the granite under action of the weather is washed or blown away, and does not accumulate soil; therefore, little vegetation covers the mountain, which is a huge light-gray dome of almost wholly bare rock, and a conspicuous object of the landscape."

It is composed so far as known of even-textured, medium-grained, biotite-bearing, muscovite granite, which is cut by pegmatite veins (dikes) varying from a fraction of an inch to 18 in. in thickness. The mountain is an important source of structural granite, and as such is the base of one of Georgia's important industries. An estimate of the exposed stone above the plane is 7,453,750,000 cu.ft.

The Stone Mountain Granite Corporation, aside from its work on the monument, is an important company. It employs in quarries and cutting plants 325 men. Production includes cut and rough stone, paving blocks, and building stone in general.

There are plants for sawing, cutting, polishing, and turning stone, with one central plant, driven by electric power from the Georgia Railway & Power Co., operating air compressors for quarry use. About 2,000 hp. is being used. The company owns its own railway, connecting with the Georgia Railroad at Stone Mountain station three miles distant. Two light locomotives are in service between quarries, cutting plants, and main line, ten carloads of product being the average daily output at present.

Central panel on the Stone Mountain Confederate Memorial. The figures are to be 125 ft. high

Time-Study Methods for Mining Operations

Unusual Conditions Underground Complicate Interpretation of Data

By G. Townsend Harley
Morenci, Ariz.

IN A RECENT PAPER[1] I attempted to develop the idea of the importance of ground classification as a starting point for all work which has as its aim the ultimate maximum reduction of mining costs by means of the classification, the improvement, or the standardization of mining methods and procedure.

Second only in importance to this ground classification for the purpose in view, is the question of time-study methods of job analysis. No matter how closely and accurately one may be able to classify ground according to its physical characteristics, unless one has an accurate means of measuring the amount of work that it is possible for a man, or a machine, or materials, to accomplish in each class of ground, knowledge of ground characteristics will be of only limited use. On the other hand, to enter into a long campaign of detailed time and motion study without first obtaining a thorough knowledge of the ground characteristics will result in the accumulation of a mass of figures of such intricacy and variableness as to be almost useless for the purpose of reduction to a truly organized body of practical knowledge.

Ground Classification First Essential

For each class of ground encountered in a mine, there is one best piece of equipment for doing the desired work, and one best method of doing the work. The class of ground is determined as outlined in the article previously published. The best equipment and the most efficient method of performing the work are to be determined only after careful and long-continued time study.

It has been demonstrated repeatedly that what were thought to be the best methods have after time study proved to be inefficient, and new methods evolved have exceeded the old performances by from 25 to 250 per cent. This is as true for mining as for the other industries; and, although much less of this kind of investigation has been done in mining than in machine-shop and factory work, for example, it can nevertheless be said with confidence, even in this preliminary stage of the work, that the same chances for improvement exist, and in equal or even greater amount.

It is therefore the duty of management, in the mining industry, to analyze carefully every phase and element of the work, according to a well-thought-out scientific method. Work of this kind will include research, experiment, and investigation, and will aim to secure all the available information on each phase or element of the business, in order to secure the basic facts upon which to lay out plans for future procedure. The means for securing this information is through the medium of statistical analyses of all sorts, job analysis, time and motion study, and fatigue study.

Once these basic facts have been determined, plans for operation and control of operations may be developed. This makes it possible so to co-ordinate the energy embodied in brain, muscle, equipment, and materials as to secure the maximum product with the minimum effort and with the minimum amount of waste of any of these forms of energy. It also makes it possible to co-ordinate to a greater degree individual and group production to the analyzed demand. The means of securing these results are proper routing of materials and products, order of work, work orders to cover each phase of the job, instruction cards, inspection, functional foremanship, progress records, and exact specifications for materials.

The preceding two paragraphs, in slightly paraphrased form, are from the chapter by H. S. Person on "Scientific Management and the Reduction of Unemployment," appearing on page 183 of "Scientific Management Since Taylor," by Hunt.

As a means to these ends, the stop watch can be used to great advantage in connection with ground classification in the following ways:

1. To determine in each class of ground, or for each operation or each kind of work, the best machine or equipment to use to obtain maximum results.
2. For the determination, through time and motion studies, in each class of ground or for each operation, of the best and most effective way to handle the best machine or equipment to secure such results.
3. To determine the best and most efficient manner of performing any job requiring physical effort, so as to co-ordinate the work of brain and muscle in such a way as to use up the least amount of energy in doing the job.
4. To check the validity of the suggestions made by any workman, against the prevailing standard of practice put into operation at some prior time.

Work of this nature is undertaken for the purpose of obtaining all the facts in the case, in the greatest possible detail, on such items as the time element of each motion, the various motions involved, and the fatigue of the worker; and, further, these figures are used to develop standard schedules of work and instruction cards to fit each condition.

Having obtained the data in such detail, however, and having studied it from all angles, its practical application in mining presents wide divergence from the strict usage and current acceptance of similar information in other industries.

The idea that any one man can go underground with a stop watch, and in the course of time so adjust a worker's every move that it becomes a standard to be attained by everyone, is clearly impossible of accomplishment. The very nature of mining precludes any possibility of the general development of the "Standard Job," even for a man doing the same work each day;

[1] "Proposed Ground Classification for Mining Purposes"; *E. & M. J.*, Sept. 4 and Sept. 11, 1926.

and in the absence of a "Standard Job" there can be no "Standard of Performance" in any but the most liberal interpretation of that term. This situation, then, resolves itself into a question of the manner in which the same class of data will be applied for different purposes and under widely varying circumstances.

Two Meanings for "Standard"

It should be noted that the word "standard" is used throughout this article to convey a double meaning. First, it is used to designate a class of job the conditions of which can all be laid down within some definite limiting factors, such as class of ground, type and condition of equipment, kind of work to be done, temperature and humidity conditions, type and size of opening, and other related details. Second, it designates the highest possible rate of production in a shift, which the workman who is of average physique and intelligence, interested in his work, and thoroughly instructed, can consistently maintain, day after day, under the (standard) conditions existing in his working place. In the first connotation "Standard Job" is a suitable term, but in the second instance "Standard of Performance" is the better term to use.

CONDITIONS characteristic of underground mining operations present a problem to the "efficiency expert" that differs in many respects from that encountered in the factory or the average industrial plant. Nevertheless, if properly interpreted, the data gathered from scientific time-study and job-analysis investigations in mines are of immense value. Such data can be used in two ways: first, to standardize and improve the machinery and equipment used in the mine; and second, to develop methods of performance for the individual worker that will enable him to accomplish a maximum of work with a minimum of effort. Exact and detailed records compiled from data obtained under average working conditions are the basis of all standardization of operations.

In any work the greatest results are obtained where both the conditions of the job and the performance of the men are at their best. As used herein the conception of the standard is different than where the term is used to designate a basis upon which to develop a special wage schedule—the latter being only a certain more or less well-defined and specified part of the standards as just described.

The means of encouraging men to work up to the highest standards that are possible under particular conditions lie within the province of the special wage-payment scheme, and are the subject of special study beyond the scope of this paper. It is stoutly maintained, however, that the standards for bonus and contract payments cannot be set intelligently until the "standards" of which we speak in this paper have been fully determined, and this in spite of the general method of setting such wage-payment standard practiced with apparent success in many places.

To secure the best ultimate results, every operation and every move must be studied, all waste effort must be eliminated, machinery and equipment must be designed and adjusted to fit the conditions of labor and the ground characteristics, and an average standard of performance must be worked out for each job in each class of ground. After that has been done, one must take into consideration the fact that no working place in a mine presents each day the identical conditions of the day before; that the men at work are scattered singly or in small groups over a large area of country accessible only through a great number of small and often intricately arranged passageways; that they are in the dark and removed from the possibility of close supervision; and that they are at work in air and humidity conditions that are never of the best and are often extremely trying. In deference to these existing conditions one must resurvey the detailed figures obtained by time study of the closely regulated operations, and recast them into fewer and more general standards of practice which will cover in a broad practical way the major differences that occur in the major classes of ground. General instructions can then be made up on instruction cards to cover these broad classes of work. New men can, and should, be taken to a particular section of the mine and placed under competent instructors who will drill them in the detailed performance of any job; but once they are turned loose from this area of instruction, reliance must be placed to a large extent on the more general instruction card, and the orders of the boss, in conjunction with dependence on the good judgment and ingenuity of the individual, to overcome in the most practical manner those differences from the broad standard which he will encounter day by day in his work.

Furthermore, to insure constant progress and increased efficiency through continually bettered standards of practice, it is necessary to go a step farther in the matter and to encourage the worker to offer suggestions as to changes and improvements in methods of work. When a good suggestion is forthcoming, it should be thoroughly tried out and if found adequate must be embodied in a new standard of practice.

Patents for new inventions should be taken out by the company in favor of the men perfecting them; rewards should be offered for suggestions, and in every way the individual should be encouraged to better himself, his working conditions, and the work of the company by which he is employed. In mining, as in no other industry, is there excellent opportunity for the exercise of independent thought and ingenuity on the part of the worker, and this apparently continues to hold true no matter what degree of standardization has been reached at the plant.

Judgment Necessary in Interpretation

Time, motion, and fatigue studies, then, have their place in mining, and are used in as great detail there as in any other industry; but for the practical application of such figures a great deal of judgment, experience, and care must be exercised to interpret, arrange, and consolidate them into schedules broad enough to be of practical operating value, without losing sight of the value of the detailed work in so doing. In machine-shop work, where operations are standard on each machine, each repetition of a job can be done in the same manner, with the same motions, the same tools, and in the same

length of time. Variations in the job are reduced to a minimum, and in the time and motion study work the quickest time in which the job has been done is in general the standard of work aimed at, due allowance being made for the fatigue of the operator. In mining, although jobs are repeated daily in much the same way, much greater unavoidable variations in time are apparent. These are due to local conditions of ground; the shape, size and conditions of headings and rock piles left by blasting, and the varying hazards which develop as a result of these. The time allowance in any standard of work for underground purposes, then, must contain larger provisions for unavoidable delays; a greater fatigue allowance for cramped working places, bad air, and the interference of other workers passing through the working area; and a time allowance sufficiently large to cover extreme cases reasonably in the most variable items of any job.

Only those phases of the work—there is a goodly proportion of such items in every underground job—that can be performed without regard to local ground conditions can be treated as in machine-shop work and the minimum time limit in which the job has been done used as a standard. For all other phases of the job, it is necessary to remain (at least for the present) on the safe side of the problem and to use figures which do not exceed a fair average time for the more extreme cases.

These methods of study, with job analysis, can be made applicable to mining in two general ways: first to standardize and improve the machinery and equipment as used in the mine; and, second, to standardize and improve as far as possible the work of the individual and to point out ways and means for him to become more efficient in his daily work. By variously combining and rearranging the results of these two types of investigations, more efficient mining systems are evolved. Although the end points of these two lines of study are different, there can be no separation of the elements of the work; the methods used and the elements studied are the same in each case. It is largely a matter of which points are to be most stressed in the final summary.

Typical Drift-Round Study

In the first instance the relative merits of two or more machines for a given purpose in a definite character of ground are desired. Such work involves the selection of the proper equipment to be used, and the best method of using it. On page 725 is a summary sheet of the cycle of operations involved in drilling a drift round. As this is only a summary sheet, it will be noted that nearly every item on it can be further subdivided for purposes of study. It is assumed that the class of ground has been thoroughly determined and that the proper type of round is known for the number of holes and their location, the proper minimum angle of cut holes allowable, the maximum depth of the round, and the correct powder allowance. It is necessary first to analyze the job into its component and fundamental parts. Among these are: the first installation and setting up of the machine; the actual productive work of the machine; the amount of shifting, adjustment, and delay involved; followed by the final tearing down and moving away of the equipment.

Next the detailed motions required of the operator to accomplish each of the above subdivisions of the job are analyzed and arranged for study. Each move of the operator and each operation of the machine is separately timed, as many readings being taken (when possible to secure them) as is necessary to secure a true average for each. Wasted motions are eliminated, inefficient motions are modified, and various combinations are made of the necessary motions involved in the work, until that arrangement has been found which accomplishes the job in the minimum total time elapsed, which gives the greatest net operating time of the equipment, and which permits of doing the work with the least amount of physical effort and fatigue on the part of the operator.

Many Processes Difficult to Standardize

Referring to page 725, the item of picking down the back to make the heading safe for further work consumes time in direct proportion to the character of the ground, and for different types of headings very definite tables can be worked out. Shoveling back loose material after picking down will vary with the picking-down time, as a general rule, and can be included in that table. Setting up the drill column will be a variable time operation, depending on the shape and size of the heading, and the condition of the back, to such an extent that no definite and close predictions can be made, and a large factor of variation must be used. Obtaining drill steel will vary with the location and distance of drill-storage racks from the heading, and a definite time allowance can be given for this item, based on tables constructed over a long period of experience. All of the other items of work in the "Setting Up" section are more or less definite in their character, are not so dependent upon class of ground or upon distances, but are more in the nature of clear-cut mechanical operations, and are consequently among those items for which the minimum time for performance, as determined by time study, may be the time allowance for general practice.

In the "Drilling" section of the sheet, the drilling speed of the machine is inherent in the machine itself, and is a function of the hardness of the ground drilled; but the time of changing drill steel, changing the position of the machine, the clamp, or the arm, and keeping the machine in alignment and in continuous operation, is subject to analysis and improvement. This work will be materially aided by designing suitable wrenches and other accessories; improving and standardizing the design of drilling machines, columns, arms, and clamps; studying the placement and proper handling of sharp and dull steel in the heading to facilitate speed in handling, and so on. The work included under the caption "Tearing Down, Loading, and Blasting" will be analyzed and studied, and arranged in logical sequence in the same manner.

Average time allotments will be determined for each of the operations mentioned, with due allowance for rest periods and unavoidable delays, and from these unit times, properly combined to fit the individual case, will be built up the proper job standards. The final job figures will be such that the average worker, properly instructed, when working at his best possible speed consistent with the maintenance of good health and mental welfare, can just about meet the requirements day in and day out. Men of inferior ability, or those uninstructed, and the uninterested ones, will fall below these standards; and a small part of the crew, made up of the extremely ambitious ones and of those

who are above the average in physical and mental ability, will, after proper instruction, be able to improve materially on the standards of work set.

If the standards as worked out in each case cannot be consistently reached by the average worker who is trying conscientiously, the conclusion is inevitable that insufficient or improper instruction has been given him, or that his tools and equipment are not up to the standards which were maintained during the test period, or that in the endeavor to make a big showing in improved efficiency the standards have been set at a point that is higher than intelligent interpretation of test results would warrant. Failure on the part of the interested worker consistently to obtain the standards set for him soon leads to discouragement, and in a short time, if proper correction is not made, an irremediable harm is done to the cause.

Drift Round Test No. 128

Standard 12-Hole Round 4'-6" Deep

Date July 10, 1926
Drift No. 10-208
Remarks:- Drift of standard shape or size (7½×5½) in excellent condition for good drilling. No interference with work, all equipment at hand and in good condition during entire shift. Round broke 4'-7". This drill round followed Test No. 127

Drill Data: Paynter Test 90% | Air Consumption 88 | Drill #36 Leyner

Ground Data: Hardness C+ | Toughness 0.89 | Slip Classification III

Working Conditions: Temperature 81° | Humidity 85% | Air Velocity 50 f.p.m.

Time		Operations	Elapsed Time Min. Sec.	Hole No.	Depth, In.	Drill Speed, Inches Per Min.	Net Drilling Time	Steel Changes. No.	Steel Changes. Time	Change Position	Lost Time	Total Drilling Time
7.30		Enters mine										
7.40		At face and ready to work	10.00									
	Setting Up	Pick down back and face to make safe	12.00	} See Table No. 10								
	Setting Up	Shoveling back loose material	2.15									
	Setting Up	Drill and equipment brought to face on truck	2.08									
	Setting Up	Drill column (arm and clamp attached) set in place, blocked and jacks tightened	7.30									
	Setting Up	Arm raised to first position and tightened	1.29									
	Setting Up	Clamp to position, drill thrown on and tightened	3.00	See Sheet 581 for diagram of round and powder allowance								
	Setting Up	Machine oiled	1.15									
	Setting Up	Air and water cleaned out and hose connected to machine	2.46									
8.22.27	Setting Up	Drill steel obtained from storage rack, sorted and lined up against drift side	10.04									
	Drilling	First drill steel put in chuck, drill aligned and all bolts tightened	5.16	1	56	8.5	6.35	3	3.18	—		9.53
	Drilling	Drilling starts. See Sheet No. 581 for further details of time study		2	56	8.1	6.55	3	3.15	3.10	—	13.20
	Drilling	Machine oiled	2.45	3	58	8.0	7.15	3	3.20	1.05	1.01	12.41
	Drilling	Resting	10.00	4	68	6.0	11.21	3	3.35	1.20	2.10	18.26
	Drilling			5	69	5.9	11.42	4	4.30	1.50	1.17	19.19
	Drilling	Machine oiled	2.15	6	68	6.1	11.09	3	3.29	2.08	0.45	17.31
	Drilling			7	70	8.3	8.26	3	3.07	4.47	—	16.20
	Drilling			8	69	8.2	8.25	4	4.15	3.05	1.05	16.50
	Drilling	Machine oiled	2.16	9	71	8.5	8.22	3	3.01	3.30	—	14.53
11.24.49	Drilling	Resting	8.10	10	57	7.9	7.13	3	2.45	2.16	2.13	14.27
12.00.31	Drilling	Lunch	35.42	11	56	8.0	7.00	3	3.05	1.45	1.59	13.49
	Drilling			12	58	7.8	7.26	3	3.50	2.55	2.01	16.12
	Drilling			Totals	756		101.49	38	41.30	27.51	12.31	183.41
12.30.32												
	Tearing Down and Loading	Removing air and water hose from machine	1.30									
	Tearing Down and Loading	Removing machine from arm	3.27									
	Tearing Down and Loading	Tearing down column and arm	5.23									
	Tearing Down and Loading	Blowing out holes, including connecting and disconnecting blow pipe	10.16									
	Tearing Down and Loading	Disconnecting hoses from pipe lines	2.01									
	Tearing Down and Loading	Piling equipment on truck and taking back from face	6.57									
1.43.16	Tearing Down and Loading	Loading holes (25:00 to get powder from magazine)	43.10	See Table No. 12								
3.10.00		Idle from 1.43.16 P.M. until 3.10 P.M.	86.44									
3.30.00		Blasted at 3.10 P.M. Out of mine at 3.30 P.M.	20.00									

During such a test, changes in the design of the equipment and the simplification and standardization of parts and accessories will be suggested, and, finally, the results of study and observation will be combined to show the effects upon a "Factor of Desirability" (After Tillson, of New Jersey Zinc Co.) of: first cost of equipment, operating cost, ease of handling, power consumption, repair cost, dependability, the length of time the machine will remain underground without repairs, and the life of the machine. Upon this factor the relative merits of machines may be gaged.

In the second case, consisting of jobs involving in the main the physical effort of the worker, job analysis and motion study are likewise called into play, the possibilities of motion study being stressed to the limit. Time study of the various motions involved is gone into in great detail, and the effect of the fatiguing of the worker is carefully noted. This may be done by dividing the day's work into parts, and noting the production rate of each of these parts. The various motions are rearranged and studied, various lengths of rest periods are allowed at different intervals, and again production and times are noted. Theoretically it is possible to get enough rest periods of sufficient duration each, into a day, to make a worker's rate of production during his net working day constant. At the other extreme, a pace can be set for a man, and so little rest allowed, that his rate of production is very low when his shift ends; he is very tired, and the continuance of such practice will injure his health. In neither instance is the total daily production high, in the first case on account of too much idle time, and in the second because of rapid tiring and a constantly and excessively decreasing rate of production. Between these two extremes lies the economic mean, at which the rate of production, the amount of rest allowed, the intervals at which these rest periods occur, and the fine adjustment of the motions of the man, with all waste movement eliminated, are so well worked out that the worker keeps his health, is not more tired at the end of the shift than a fair day's work should make any healthy man, and yet whose productive capacity has been increased enormously.

The cost of equipment, repairs, and other complementary work is likely to be negligible, although the proper design of equipment cannot be stressed too greatly, and the physical and mental effort and welfare of the worker are of paramount importance. In the summary, the selected motions are described and an

average time element is given to each. The correct combination of the different component motions and times gives the standard of performance and the standard time allowance per unit of work. The number of units per day, after making allowances for proper rest periods, miscellaneous items, and unavoidable delays, which in some cases may be utilized as rest periods, with other related data, is the measure of the maximum productive capacity of the man, which is the objective of the study and the records.

Details of Time-Study Method

For full details of the method of making a time study having the second general object in view reference may be made to my report on this subject in the *Transactions* of the A.I.M.E. for 1919, "A Study of Shoveling as Applied to Mining."

Other conditions to be carefully noted during the progress of test work are: the general condition of the working place in which the tests are being conducted; the quality, kind, and physical condition of the materials used in performing the work; the type and condition of machinery and equipment being used; and all other information which may have a direct or indirect bearing on a particular set of test figures. Too much information covering these and related details cannot be gathered in describing the conditions of a test. Much of it may be thrown out later as useless, but one small bit of information missed may later cast a haze of doubt over the whole series of figures.

Uniformity of the general conditions surrounding a series of tests is essential if time and motion study is to be conducted on a correct and strictly comparable basis. Among the conditions which should be carefully observed may be noted:

Character of Ground—All ground in which tests are to be carried on should first be accurately classified, and all tests should bear a uniform notation of the complete classification for the kind of rock, its hardness, toughness, and position of slips, and any other information pertinent to a complete control. In the inspection of time-study tests, only those tests bearing the same classification should be considered as belonging to one group. Later the group totals and averages may be compared, one with another, and finally certain groups may be combined into larger classes for which general standards and instruction cards may be made out for practical use. Great leeway is possible here, and keen judgment must be used in determining just how far the process of combination may be safely carried on, in order to get the mass of information into practical working form, and yet so as not to offset the value of the constructive, detailed work already done.

Class of Men Subjected to Tests—The type of man used for test purposes, whether in testing machinery or equipment or on a job requiring purely physical exertion and stamina, should be carefully considered. Obviously, the least intelligent man, and the poorest physically, would not be considered for a moment as a factor in a test designed to get the best out of a machine or a job. On the other hand, the exceptionally qualified man will produce results, under test conditions, that will be unattainable generally, and such a man is no more qualified as a laboratory subject than is the exceptionally poor man. Men should be selected as representative in all respects of the great middle group —the average man at work in that particular mine or district. They should be of average size and weight, of average intelligence, energy, dexterity, and endurance. But, above all, they must be willing and cheerful, ready to respond to suggestions and changes in their accustomed method of working, even under trying conditions and when they think that the investigator may be wrong. Great differences will be noted between the different nationalities, in the way they respond to the new order of things; and tests should be conducted with the men of the nationality predominating in the district.

Comparison of Surface and Underground Conditions—Identical tests carried on with the same man working on surface and in well-opened places underground will give the relative efficiency of the man at work under conditions of mine air and humidity and poor lighting, as compared with the ideal conditions of surface work. The further differences between tests in these unrestricted areas underground and the ordinary mine working place will give an idea as to the amount of interference and delay which results from cramped working quarters, timber obstructions in place, and the passage of men and supplies through the working place. In all tests, data should be gathered on average temperature, humidity, and air velocity. A chart showing the relative efficiency of men working underground under different conditions of temperature, humidity, and velocity of air currents can be worked out after a long series of observations, and it may be used to very good purpose.

Paraphernalia for Efficient Recording

Time-study reading must of necessity be taken and recorded with great rapidity in most instances, and unless the tools of the observer are conveniently arranged, he will find himself constantly in difficulties. A recording board has been developed which appears to serve all purposes fairly well. It is 14 in. long, 10 in. deep, and made of $\frac{3}{16}$ in. material, soft pine being used for the center in which to insert small thumb tacks, and a hard-wood border, to make it rigid. For convenience in carrying underground, the board may be split up and down through the center and fastened with small hinges. A thin strap passed through lugs on the back will hold it rigidly open when in use. The board is held near the top, between the crook of the elbow and the last three fingers of the left hand. This leaves the thumb and first finger free to manipulate the two stop watches which fit into recesses in the upper right-hand corner of the board. These recesses are backed with leather and have a rim of the same material fitting snugly up to the dial in front, similar in arrangement to a leather wrist-watch strap. The dial of the stop watch, which is operated by the forefinger, must be at right angles to the stem, so that when the watch is in position on the board, with the stem extending out at the end of the board directly under the forefinger, the figures will be upright. A great deal of thought can well be given to the form and arrangement of time-study sheets, before any of the real work is done. In general, it is well to have two time sheets; one at the left-hand side of the board for general notations, remarks, and casual readings on rest periods, delays, and related details, and one at the right, directly under the watches on which will be the carefully arranged detailed time-study data.

Interpretation of the results of time study, and the

final selection of a fair time for the performance of any one motion or job, from a series of time readings, is of interest and of great importance and is, as well, a question of considerable delicacy. Mathematically the average of the various readings may be found readily, and it is easy enough, by one means or other, to eliminate extreme or erratic figures from the series. But does this always suffice to give the practical result for underground purposes? Underground, where the opportunity is seldom afforded for complete separation of test work from that of the daily routine of ore production or development, in many instances a few figures on one feature of the work may be all that will be obtainable, within a given space of time, and upon these estimates must be based and all correlations and combinations built up. It should be clear, then, that mathematical considerations do not enter into the problem with the same degree of finality as in surface work under more closely controlled conditions; and to a correspondingly greater degree experience and judgment must be relied upon to serve as guides as to procedure and practice.

This is not to say that results should not be obtained mathematically to as great an extent as possible, but rather that variations will often be so great in a series of test figures taken underground that only a man of experience can make a correct and balanced estimate which will have practical value. In general, the more complicated the job that must be studied as one operation, the more variable the conditions attending the work; or the more irregular the indivisible elements of that operation, the greater should be the number of readings upon which to secure the final average. Conversely as the possibility for prolonged and careful study becomes impracticable, one must depend upon knowledge and experience gained in other test work, considering the degree of skill involved in the job, the speed at which the men perform the job compared with their ability to withstand the onslaught of fatigue during the shift; one's experience in practical mining, the regularity with which the job will turn up in a day's work, and the degree of sameness in its details which it will present each time, must be determined.

Shift Bosses Usually Low in Estimates

It is interesting as a side light to note here that in several years of underground experience I have found only two underground bosses who, without special experience, have been able to estimate even approximately what it is possible for an average man to do in a shift. As a rule all such estimates are too low, and apparently agree with what is being done daily, on a day's pay basis, without regard for what the possibilities of each job may be. Occasionally, however, one comes across a man who has in mind, on any job, the best single performance of some very exceptional man, and these records he will present when questioned as to the daily result to be aimed at by all. Needless to say, such estimates are misleading and useless, and only a careful study of all these questions with the aid of a stop watch will throw the subject into its true perspective.

One of the interesting features of a campaign for the general betterment is the organizing and starting of the program. The big question, of course, is where best to make a beginning. There would appear to be two possible places, the first being in that branch of the work in which the largest immediate showing of results can be made, regardless of the possible effects on other work; and, second, in that department which will best fit the mine for uninterrupted and continuous progress, without temporarily halting, or adversely affecting, the work of any other department.

The first plan is the easier at the start, and is indeed at times necessary in order to demonstrate to a certain type of management that a real benefit is to be derived from the work. It is only natural that one should want to secure as big a showing as possible, at the earliest possible moment, from what is looked upon as a nonproductive department, but it is quite conceivable that such a start may lead to confusion later, when one department of the operation has improved its capacity to such an extent that the succeeding departments are not able to handle the product. One always has recourse to the expedient of laying off men in any department that is overproducing, but in view of the fact that a department has just put on a campaign for improved efficiency, the laying off of men in that department as soon as results have been accomplished is bad policy in that it supports one of the strongest arguments of labor against scientific management methods. In isolated localities, too, a crew is often built up only over a period of years, and ordinary replacement is often trying enough without actually letting some of the crew go in a body on account of a temporary condition brought about by a poorly arranged campaign.

The second scheme is essentially that of the farsighted management, as more often than not, under this policy, although tangible results in the form of definite savings do not begin to show for a year or more, the final results are likely to be greater, obtained in a shorter total time, and with less confusion and delay in operations.

Suggested Order of Studies

Results are not to be obtained with equal facility in the different phases of the work studied, and in the order of their increasing difficulty they may be generally set down about as follows: hoisting; haulage; the bringing up to maximum efficiency of the tool and supply distribution system; ventilation conditions in the mine; improvement and standardization of all machinery, equipment, and supplies used throughout the mine; improvement and standardization of shoveling and drilling methods; improvement and standardization of the types of timber used and of the manual operations of timbering; and, finally, the most difficult and delicate of all, the arrangement of the various single phases of the jobs so far studied to make a complete set of schedules, or job standards, first for development work and lastly for stoping methods.

One safe and logical way to proceed is to start with the last operation in the sequence first, and to build up the capacity of that operation to the greatest desired production of the plant. Considering the mine only, this last operation would be hoisting. A program would be worked out showing the method of operating and the number of men to be employed for each stage of production up to the maximum. The task of improving hoisting is largely mechanical, changes being based for the most part on time studies of the cycle of operations of the hoist itself. The men are so located and their work is so arranged as to handle the job to the best advantage; all wasted time is eliminated by bringing each operation up to its maximum speed by

redesigning the plant, enlarging pockets, reducing the number of levels at which hoisting must be done through the medium of long storage raises, and installing automatic devices for loading. When finally so designed the plant will be kept operating at full capacity for one, two, or three shifts, as the conditions may warrant.

The work of hoisting will be followed naturally by a brakemen, to load and dump their own cars. This resulted in a greater daily tonnage, but the total costs were higher. Systematic time-study methods were then brought to bear on the subject, which resulted in a third method, arranged to use one locomotive and three full trains of cars. The locomotive driver took a train of loaded cars to the station, switched to a train of empties standing there, and took it back to the chutes,

Preliminary Estimate of Savings to Be Made

By means of a completely organized and conducted Time and Motion Study Program

	Actual Current Costs				Least Cost Known at Other Plants for Similar and Comparable Conditions	Estimated Future Cost and Saving					Estimated Cost Per Ton With Maximum Production Under Improved Operations	Remarks Preliminary Notation or Order in Which the Studies Shall Be Made
	Units	Total Amount	Cost Per Unit	Cost Per Ton		Cost Per Unit	Per Cent Saving Per Unit	Cost Per Ton	Saving Effected Per Ton	Per Cent Saving Effected Per Ton		
Stoping	75000T	75,000.00	1.00	.75	.55	.80	20.00	.60	.15	7.30	600	6
Stope development	2500ft.	25,000.00	10.00	.25	.20	7.50	25.00	.19	.06	2.90	190	5
Exploration and development	1600ft.	20,000.00	12.50	.20	.15	10.50	16.00	.17	.03	1.50	170	4
Underground repairs		2,000.00		.02	.02			.02	–	–	* .017	
Hoisting		10,000.00		.10	.04			.06	.04	1.90	* .050	1
Hand tramming		4,000.00		.04	.04			.04	–	–	.040	3
Electric haulage		10,000.00		.10	.06			.07	.03	1.50	.070	2
Pumping and drainage		3,000.00		.03	.03			.03	–	–	* .025	
Ventilation		2,000.00		.02	.01			.02	–	–	* .017	
Assaying and sampling		4,000.00		.04	.03			.03	.01	0.50	* .025	
Mine Dept. expense		10,000.00		.10	.10			.10	–		.100	7
Total controllable expense		165,000.00		1.65	1.23			1.33	.32	15.60	1.304	
Indirect												
General expense		20,000.00		.20				.20			* .167	
Taxes		15,000.00		.15				.15			* .125	
Depreciation and depletion		5,000.00		.05				.05			.050	
Total mining cost		205,000.00		2.05				1.73			1.646	
Monthly tonnage mined				100,000				100,000			120,000	

Note:- Items marked thus * are within moderate limits, constant in amount, and cost per ton will decrease as tonnage is increased. Other costs will remain practically constant per ton

study of the haulage and tramming systems in the mine. Although not normally accounting for more than 5 to 8 per cent of the total cost of mining, and a big saving in this work being therefore not particularly noticeable in the total cost, it is essential that haulage and tramming be next considered in order that any substantial improvements later in actual production of ore will not be blocked by choked chutes and haulage raises and an overcrowded and disorganized haulage system.

An Illustration of Improved Efficiency

To cite only one example of improving haulage practice, the original plan of operation on one of the levels at a medium-sized property consisted of using one locomotive with a full train of cars, and a few extras. The extra cars were loaded at the stope chutes by a loading crew while the train was being taken to the station. At the station was a sampler, who helped the brakeman dump the cars. When the train of empties was returned to the stoping area, the loading crew began to load them while the locomotive crew switched and connected with the extras already loaded. As soon as enough cars had been loaded to make up a "trip," the train pulled out, leaving the loaders to finish on the remaining empty cars. With this method in use, there were times during each trip when the loaders, train crew, and sampler at the station were idle. The second plan tried was to put two motors on the level with two trains of cars, allowing each motor crew, composed of one driver and two there switching at once to a loaded train and starting back to the pockets. At the pockets one man sampled and dumped the cars with the aid of a Little Tugger hoist used as a winch to draw the train along and spot the cars over the chutes. An air cylinder installed at the chute aided in dumping each car. Under the stope chutes, a small crew of loaders was able to get a train loaded just as the locomotive arrived for it. All light rails were taken up, and 45-lb. steel laid in place; switches were either of automatic spring type or especially rigged so as to be operated by the locomotive driver from his seat on the engine. An automatic signal system was installed at each crosscut, curves of wide radius were constructed and the whole system kept in perfect alignment and repair, so that maximum haulage speeds could be maintained. Later, as this level grew in extent and tonnage, a small gathering locomotive was used to aid the loading crews. This last plan of operation produced more tonnage per shift than either the first or second method, with a smaller initial capital outlay and a lower total operating cost than any other haulage system of similar capacity with which I am acquainted.

After the study of haulage, it will be advisable, in more or less the same order as enumerated above, to improve the details and general method of conducting the other underground departments of the mine, so that they may work together with the least possible waste and duplication of effort. Improvement in develop-

ment methods may then follow, and finally the attention will be devoted to a thorough overhauling and study of the operations of stoping, a task which in reality amounts to combining, in their true relationships, all the elements so far studied. By the time the study of stoping has been begun, the ultimate capacity of the mine (with the prevailing equipment and arrangement) has been definitely determined, and improvements in stoping can progress up to this limit. Any further improvement in stoping methods beyond this point will simply mean a corresponding decrease in the number of men required to secure the maximum tonnage.

Order of Study an Important Element

To make a 10 or 15 or even a 25 per cent saving in the cost of operating one department of a mine will often produce less tangible results than to make a 5 per cent saving in one of the larger departments. It is well to bear this in mind, and whenever possible to make a choice between plans for study. Whenever it is practicable without interfering with the general and regular progress of the mine, the larger department should be worked on first.

On page 728 is presented in tabular form information that may be gathered to throw light on the subject prior to initiating a complete campaign of betterment, and the inferences that may be drawn therefrom after some estimating has been done. Upon the accuracy of the estimates, and upon the degree of judgment used in selecting the order in which the various problems will be studied, depend largely the smoothness and general satisfaction with which the work will proceed later. Being fully cognizant of the fact that no two mines are ever alike, and that never, probably, will the same method of approach be practicable, except in broad principles, this chart is submitted without further comment for what it may be worth.

Goal to Be Reached

Time study is only a single step toward the goal of better management, which in large degree consists of and connotes a higher rate of production, a decreased cost of production, and the entire elimination of waste of materials, resources, and human and mechanical energy. In addition there is a higher standard of living for all employees, a higher rate of pay, and a more contented group of people comfortably housed in sanitary and pleasant surroundings, and with facilities for education, advancement, and recreation at hand.

Mining has been an activity of man since the early dawn of history; it is possibly the oldest industry in existence, in the sense that it was the first united effort of a group of men, as against that of the individual, to produce an economic good; and yet in some respects it is the most laggard of them all in point of progressiveness. Mechanically the industry has made great strides. Possibly it is even at a parity with any of the others in this respect, but in its underground aspects, and on the human side, progress has been by no means so sure. Notwithstanding much talk to the contrary, campaigns for improved management methods have not yet been sold to the general run of mine managers, and in the majority of cases the close relationship of profits to management methods is not clearly recognized or understood. The high values obtaining in ores in the earlier periods of mining have made it hard to see the need for closer supervision of the work as long as profits have been high; and the owners have been satisfied. But times and conditions have changed. We are holding to more enlightened views on the subject of conserving our natural resources, and with the depletion of the higher grade deposits, work is being done on material that only a few years ago was classed as waste and given no further consideration.

One of the most efficient underground plants in operation today is mining an ore containing slightly over 1.0 per cent copper, at a cost of about 10.6c. per pound, and with copper selling at 13.5c. per pound or over it can show excellent results. But this plant was developed and built up almost entirely during a period in its history when the grade of ore was considerably over 2.0 per cent, and it may be questioned whether it could now be operating at a profit if it had had to develop its plant completely on the present available grade of ore. The new mines of the future will, in a large measure, face just this problem, and they must look to further economies in operating costs if their ventures are to make full return on the capital invested.

Labor Big Factor in Mine Costs

In mechanical details a large improvement may be looked for, particularly underground, where more efficient drilling equipment will be evolved; automatic hoisting, loading, and dumping plants will be installed; mechanical methods of shoveling and moving ore will supplant the present hand methods; and where new mining methods will obviate even the necessity for installing mechanical ore-moving devices. But here, too, limits may be seen to exist, and among these may be an orebody of such character, shape, and size as to demand a more expensive mining method for its winning; or the property with such small proved ore reserves that no economy can be expected through the installation of a highly expensive underground mechanical plant. It is from labor, then—that item which accounts for 50 per cent or more of the total cost of mining—that one must hope for economies sufficient to make the development and mining of low-grade bodies profitable; and in this connection, too, it must be borne in mind that a part of any saving made in this phase of plant operation must be returned to the laborer in one form or another, as a reward for his interest and increased effort and as an offset to a steadily increasing standard of living.

Whether the scene of action is an office, a smelter, a mill, or a mine, the same relative opportunity exists to better the effort of the individual and the results to the company, by a close study of the science of each job. The department that produces efficiency in its individual workers or method produces an efficient organization. It is through the scientific study of the relationship of the job to the man, of the man to his surroundings, and of the nature and capacity of man himself, that the best results will be secured. To this end, discipline alone, or rigid inspection and supervision alone, cannot be relied upon; but these together, with the proper research, teaching, inspirational factors, and the correct application of principles, will bring out the best that is in the worker.

If the profits from mining are to be maintained on ever-decreasing grades of ore, the individual must be concentrated on. Increased efficiency in mining can come, in the last analysis, only through his personal effort.

Useful Operating Ideas

Cyanide Precipitation Refinements

By H. W. Shoemaker
Mill Superintendent, Lake Shore Mines, Ltd., Kirkland Lake, Ont.

In the precipitation of rich gold-bearing cyanide solutions, the reduction of the last 2 to 5c. per ton down to a trace of gold in the tailing requires, in addition to skilled operation, certain mechanical refinements that may be easily applied to the conventional Merrill-Crowe system. These are as follows:

The use of paper as a filtering medium is becoming more popular, with the manifest advantages of time saved in cleaning up and reclothing the precipitation press and lowered cost for supplies, as well as the fact that paper over 8- to 10-oz. duck is a more efficient filter than sheeting over canvas. But in such situations where the source of power for driving pumps is not dependable, or interruptions of solution flow that result through other causes are unavoidable, paper is not usually considered safe. This is because of the fact that after a sufficiently heavy cake of precipitate has collected on the paper, cessation of pumping allows the cake to fall and tears paper with it, leaving the bare canvas, which is an indifferent filter of gold slime unless heavily primed with zinc. This is much more noticeable with square-frame presses, such as the Shriver, than with the more commonly used triangular type, such as is usually supplied with a Merrill installation. If paper is to be used safely under such conditions, the remedy is to install a swing check valve in the solution main near the presses, and between it and the pumps a vacuum release of the ball valve type. This allows leakage back through the pumps when stopped, but holds solution in the press, thus supporting the paper and making priming unnecessary when pumping is resumed.

Reciprocating pumps are the most common for this service, and, for mechanical as well as metallurgical reasons, it is advisable to eliminate the pulsations of pressure in the solution line. This is usually solved by the use of air chambers at the pump discharge. But solutions already de-aërated by passage through the Crowe vacuum receiver are particularly lively in reabsorbing any stray air that may be brought in contact with them. Hence the air chamber is soon emptied of air, and its cushioning action ceases. The chamber may be recharged with air by connecting it with an air line having sufficient pressure to overcome the solution pressure at the pump discharge; but by so doing the deaërating process is in an equal degree nullified, and additional zinc is required to maintain efficiency. One method of eliminating this trouble is to interpose a flexible seal between the air in the air chamber and the solution it is expected to cushion. Another method is to substitute a spring alleviator for the air chamber. At the Lake Shore mill this condition is met by using a diaphragm-pump base connected to the solution line and substituting for the diaphragm a circle of heavy elevator belting having no opening. Above this is clamped a cover plate opening into the usual air chamber above. This air drum is provided with a gage glass, and, after assembly, enough water is poured into the drum and above the belting to fill the gage glass to a mark one inch above the lower fitting. The top of the drum is connected through a valve to high-pressure air for balancing pressure. When operating, the water level is an index of air required to balance the solution pressure. An adjustment once a day is all that is required, and there is no possibility of the air in the chamber reducing Crowe efficiency.

If the zinc feed is to be kept at a minimum it must be fed absolutely uniformly and in a fixed ratio with the solution flow. This necessitates accurate measurement of solution flow, and at this plant the use of a Venturi tube with recording and integrating device is satisfactory. It is also a factor in estimating accurately the gold to be expected at clean-up and is a check on theft. The ordinary zinc feeder does not feed continuously but in a series of dribbles. This intermittent feed is averaged up in the feed cone by the addition of a mechanical tapper to the zinc feeder. By thus cutting down the interval between portions of zinc dropped from the end of screw, a better average feed is assured. Any zinc dust will benefit and be of higher efficiency if tumbled in a miniature ball mill with an odd dozen of 2-in. steel balls. This treatment breaks up any agglomerates caused by dampness and rubs all the particles free of oxide and carbonate which unavoidably are present.

Unless lead be present in the ore under treatment, addition of small quantities of soluble lead salts is invariably beneficial in attaining best results. Though the use of lead acetate is well established by custom, the nitrate has several characteristics which make it preferable. It has a higher lead content, is purer as usually obtained commercially, and is more soluble. Its feed is small, about 0.01 oz. per ton of ore in practice at the Lake Shore mill, but, like the zinc, it should be fed as uniformly as possible. Portions of the daily feed, in concentrated solution, are added to a large diluting box fed by a small stream of pregnant solution and overflowing to the main storage tank. Under no circumstances is this concentrated solution to be fed at the vacuum seal cone with the zinc dust.

Most installations of the Crowe process include a single-cylinder vertical air-cooled vacuum pump, 6x 4½ in., made by the Gardner Governor Co., of Quincy, Ill. In this service there is a marked tendency for the oil to be sucked by the piston and expelled in the exhaust to a degree that leaves the oil level too low unless frequent additions are supplied. After burning out several bearings, the small oil gage provided by the manufacturer was replaced with a sight oiler in which the oil level can be kept about three inches higher. In addition, the exhaust was piped directly back to the crankcase. Oil pumping now is a distinct advantage, as it seals the valves more effectually and is returned to the crankcase for re-use. Lubrication is assured by the

higher oil level and the practical absence of leakage, since the actual amount of air displaced after the receiver is up to vacuum is small, and it escapes through the breather ports after dropping the oil.

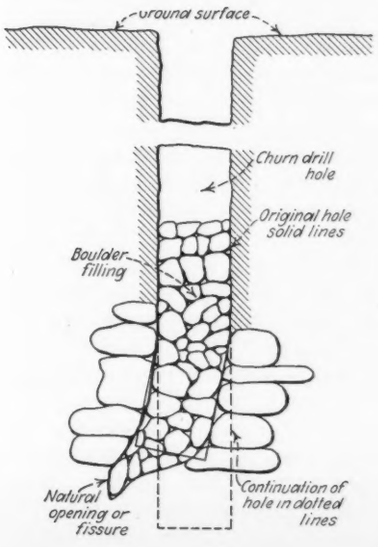
Another improvement in the operation of this pump can be effected by giving the intake valve more clearance and a quicker return. The additional clearance is provided by machining the lower side of valve plate $\frac{1}{32}$ in. To make the valve return quickly to its seat, four of the holes through the valve plate were half plugged from the top and in the recesses thus made stiff coil springs were placed. These changes converted a mechanical nuisance, incapable of more than 20 in. of vacuum, into a smooth-running, foolproof machine pulling within 1 in. of the barometric maximum.

The present triplex plunger type of pump is soon to be replaced by two-stage centrifugal pumps with special seal arrangements. At the Lake Shore, the installation of the Crowe receiver is one of high head with respect to the pumps serving the precipitation press, so that there is no possibility of sucking air at the glands, but for installations of low head this type of pump would probably have to be run submerged to eliminate the possibility of sucking air.

The combination described in the foregoing has made it possible to precipitate gold solution of $8 to $10 per ton to a tailing solution of a trace to 1c. with a zinc consumption of 0.45 oz. per ton of solution and lead nitrate 0.002 oz. per ton. The resulting cost is $0.03 per ton ore for precipitation and $0.03 for the final refining, which is a direct smelt resulting in bullion of 850 total fineness.

Churn Drilling Fissured Ground

In drilling badly fissured ground with churn drills there is always trouble caused by the swerving of the string of tools out of its vertical course. In the Southeast Missouri lead district this difficulty is overcome by filling the fissured portion of the hole with small rocks and stones of the same kind as the formation penetrated, as indicated in the accompanying figure. This portion of the hole is then redrilled. Occasionally it is necessary to repeat the procedure two or three times, but often the first trial is successful and the abandonment of the hole is thus avoided.

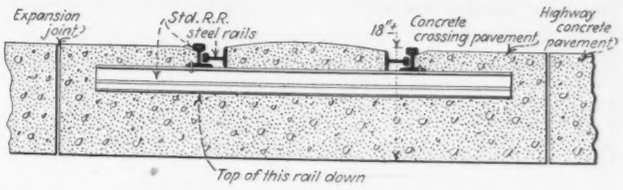


Correcting a crooked churn-drill hole in fissured ground

Mine Railroad and Road Crossing

By Roy H. Poston

The accompanying sketch indicates a type of construction used in the Southeast Missouri lead district where an industrial railroad crosses a concrete highway road. The crossing was devised to minimize repairs. Rails



A type of construction for an industrial railroad where it crosses a concrete highway

are bolted to cross-ties consisting of short sections of rails placed with the heads down. Two additional lengths of rail are placed on their sides with heads in the space between head and flange of the track rails in the section. The whole crossing is then concreted, expansion joints being left on either side of the track.

Measurement of Air in Airways

In a recent bulletin of the University of Illinois, A. C. Callen and C. M. Smith reported results of investigations upon the measurement of air in mine airways and reached conclusions some of which may be useful to metal mining engineers. These are as follows:

It is possible to measure air quantities in coal-mine airways by pitot-tube traversing methods and to obtain check results that are reasonably accurate when it is remembered that the quantity of air flowing in a mine airway is variable, being affected by a number of mine activities. Satisfactory results can be obtained only when extreme care is used in every detail of the work.

Though check results can be secured by anemometer traversing, the values thus obtained are much higher than the true quantities. It seems improbable that anemometer determination can be relied on unless the anemometer is calibrated under the exact conditions of use.

Rapid cross-sectioning to obtain areas and perimeters of airways is possible by using a modified plane-table equipment. This method is just as rapid as and more satisfactory than the offset method.

The value of k for different conditions of normal entries varied from 0.0,000,000,046, for a stretch of straight, clean air course with smooth roof and floor and only occasional props, to 0.0,000,000,095 for a straight air course with sinuous, irregular ribs, little timber, and with much débris on the floor. For a straight, clean haulage entry with smooth roof and ribs k was 0.0,000,000,051.

Isovels (lines of equal velocities) constructed from traverse section observations show a distorted velocity distribution. This irregularity is evident even in sections that might be supposed to have uniform air flow.

The effect of the disturbances on ventilation produced by the normal operating activities of the mine is very marked. Not only are there appreciable changes in quantity, but the pressure losses show great fluctuations that are the result of the changes in the circulation of the air caused by opening and closing of doors and by trips of cars obstructing the entries.

Discussion

"Engineering and Mining Journal" is not responsible for statements or opinions published under "Discussion." In many cases the views expressed are diametrically opposed to editorial policy and belief. Letters will not be printed unless the author's name and address are known to the editor.

Ancient Copper Smelting

THE EDITOR:

Sir—Mr. Walker has the best of me in regard to Bangweolo! How that name replaced Benguella is more than I can say; it is the kind of slip that the French impute to *la malice des choses*—the cussedness of things. Of course, as the context shows, I was quoting Mr. Walker's statement in regard to the shipment of copper early in the seventeenth century from the port of Benguella. I am as well aware of the separate identities of Bangweolo and Benguella as of those of Spokane and Seattle; however, some of my readers are not, and so Mr. Walker makes a justifiable correction, at my expense. The point at issue, however, is whether the copper shipped from Benguella came from the Katanga, 1,100 miles distant, or from a nearer source, which, I suggested, was Bembe, less than a hundred miles from the west coast. Even the statement quoted from Monteiro does not help us much. In the first place, a casual remark that the Portuguese had mined copper at Bembe, or elsewhere, 350 years ago is not convincing in the absence of evidence, preferably from Portuguese sources; next, we are discussing "ancient" copper mining in Central Africa, in the interior of the continent, and not at a place near the coast. Moreover, whether the mining was done two hundred or four hundred years ago, that would not warrant the adjective "ancient."

If there be "abundant evidence that more copper was mined *prehistorically* (my italics) in Africa than all the rest of the world," it should be forthcoming. The fact that one does not know with certainty when the primitive mining in the Katanga was done, nor by whom it was done, precludes any such confident statement. I gave my opinion that it was done during the last two hundred years by the natives under the direction of the Arabs. That they penetrated the interior—"war-cursed, man-eating, lion-infested," as Mr. Walker says—is proved by statements of the Portuguese historians. De Barros (1496-1570) records the fact that the Portuguese traded with the Arabs at Sofala, and that these obtained gold by personal dealings with the natives of Monomotapa, the region of the old mines of Rhodesia, made famous by another archaeological mare's nest—namely, Zimbabwe.

Dr. Hans Sauer told me that, in 1894, he found a stone temple of apparently Arab origin at a place 50 miles southeast of Bulawayo, and that at this place he and his companions gathered 800 oz. of alluvial gold scattered on the ground, as if left by owners that had fled from a predatory raid. He found also one Portuguese bronze cannon and an iron cannon, of English make, both of them of fifteenth century manufacture. This locality is still far from the Katanga, but it indicates that the Arabs did penetrate the African hinterland.

Mr. Walker quotes P. K. Horner. Yes, I know Mr. Horner quite well, and if I referred to him as "an English mining engineer," he will, I trust, pardon me, with a smile. When an engineer has his office in London and acts for English clients, he is not far from meriting the description. However, that is by the way; Mr. Horner, by his long familiarity with the Katanga, is well qualified, as Mr. Walker suggests, to give valuable evidence on this disputed question. If he, Dr. Sauer, F. E. Studt, and others whom I could name, will assist in throwing light upon the identity of the people that worked the Katanga copper mines, and will give also data concerning the period of that exploitation, the readers of this journal will be grateful, and historic research will be enriched. T. A. RICKARD.

San Francisco, Calif.

The New Riverside Ochre Co.

THE EDITOR:

Sir—We direct your attention to the article in the April 2 issue entitled "Cartersville, an Important Mining Center of the South." The writer not only greatly minimized our operation (the New Riverside Ochre Co.) in this district, but also did us quite an injustice by publishing a statement to the effect that our plant is largely owned by the Armstrong Cork Co.—a statement that is absolutely untrue, and one that will hurt us very much with our other customers (who are competitors of the Armstrong Cork Co.) in case they should happen to read the article.

We are the only successful operators of both ochre and barytes from the same location. Our shipments very often run as high as twenty cars per week. We operate easily the largest and most modern ochre plant in the district. Our barytes plant, which was built some two and half years ago, has practically upset all previous theory as to the correct method of handling the ore. In that we have completely eliminated the old picker belt, and in its place installed crushers reducing all material down to jig size, and in the operation of our jigs have successfully devised a means of bringing the hutch product up to 94 per cent barium sulphate. Therefore, through the hutch saving alone the efficiency of our plant has been increased some 30 per cent over the old type.

Most of the development as mentioned herein has been quietly accomplished at our property within the last four years, and in view of the fact that we are located off the main highway, the extent of our operation is really not generally known. However, we own and operate a standard-gage locomotive over a three-quarter mile branch line. In fact, we feel that we are the largest single operators in the district with the exception of the Ladd Lime & Stone Co.; yet the writer gives us the glowing position of employing twenty men, owning seventy-five acres of land, being controlled by

an outsider, and shipping durn nigh 3,000 tons per year —none of which is true. J. R. DELLINGER,
Cartersville, Ga. The New Riverside Ochre Co.

California's State Mining Bureau

THE EDITOR:

Sir—In the issue of March 19, on page 474, in your editorial about the California State Mining Bureau, you state: "Years ago California had a geological survey, but this was discontinued and in its place was established the State Mining Bureau in 1893." May I offer a correction as to the date. The original State Mining Bureau Act was approved April 16, 1880, and Henry G. Hanks was appointed the first State Mineralogist thereunder. In March, 1885, a supplemental act was passed providing for the appointment of a Board of Trustees which had direction and control of the bureau, but the appointment of the State Mineralogist for a four-year term remained in the hands of the Governor. This act was amended in 1893 and in 1913. At the latter date, the Board of Trustees was eliminated and the term of the State Mineralogist changed to "at the pleasure of the Governor."

There were in reality two "geological surveys" which preceded the State Mining Bureau: first, from 1851 to 1856, under John B. Trask, State Geologist; and second, from 1860 to 1874, in which period J. D. Whitney was State Geologist.

The fundamental idea expressed by the founders of the California State Mining Bureau was that, while also involving the functions of a geological survey, it should be concerned primarily with the economic phases of promoting and developing California's varied mineral resources. WALTER W. BRADLEY,
San Francisco, Calif. Deputy State Mineralogist

More and Better Carbide Lamps

THE EDITOR:

Sir—My plea, to quote the dying words of Goethe (who, as you may remember, was something of a geologist himself), is *"Mehr licht"*; or, as the Kiwanis would doubtless translate it, "More and better light."

Since the carbide lamp has *(Dieu merci)* replaced the candle, it has incidentally entered into a neck-and-neck competition with the broken ladder-rung for first place as a cause of profanity among miners. The offending instrument finds itself tickled with a wire, shaken, opened, spat into, and perhaps, in a fit of exasperation, thrown down the nearest winze amid an obscene and blasphemous flow of English, American, Spanish, or Cousin-Jack, according to locality and linguistic preferences.

Though occasionally some rare paragon among lamps may be cherished by its jealous owner above much fine gold (and this, for a miner, is no mean valuation), the common product of the factory is not thus but far otherwise. It flickers and sputters, it bubbles over with fiendish glee, and when raised to heaven, or at least as high as the back of the stope, it exudes a mighty outpouring of hot water into the sleeve of its long-suffering collaborator. The perpetrators of the instrument have endowed it with automatic lighters, automatic water-feeds, and automatic cleaners (few of which work), but entirely forget (and it troubles me much) that one of the objects of a lamp is to give light and not (for example) to economize in carbide.

I once worked in a camp in which, immediately upon requisitioning a lamp, we sent it to the machine shop to have its reflector and jet summarily amputated. A burner was made from a Leyner water tube and inserted so that the flame would be from three to four inches long. A reflector was fashioned from solid brass to replace the miniature tin dish—a ritual which leads one to wonder what laws of nature prevent all this from being done at the factory. And ah, that the genius of man might devise a non-leakable stopper for the carbide lamp!

I, for one, shall be content to light my flame with a match, and adjust the drip with my thumb, but my prayer to the lamp makers is that they hasten the millennium when we may have a reflector that shines as a good deed in a naughty world behind a flame that not only permits us to see but to place handwriting on the wall, that the sampler who runs may read, for the miner as well as the aviator is wont to indulge in smoke writing. If some benefactor will give us this, what a generation of mining men will rise up to call him blessed! ALADDIN, JR.

Mazatlan, Sinaloa, Mexico.

Imagination for the Mining Scout

THE EDITOR:

Sir—When, to what Mr. Cragoe and Mr. Emmens have said, I add that one of the most necessary and valuable attributes of a mining engineer is imagination, I will be criticized and derided, no doubt, and might lose my job if there were someone to fire me. But it is true.

Of course, it's got to be tempered imagination—modified by courage, good sense, knowledge and experience, and with the ability to balance all the factors entering. And optimism—that is another needed qualification. It is the pessimist who must put a foot rule on ore, enough to pay back the buying price, who never recommends anything. He is frightfully costly to his principals, because they lose every chance he gets his eye on. He is the chap who figures that most prospects fail, and that the chances are ten to one in his favor if he just naturally turns down everything; that this attitude will make him a reputation as a careful and conservative man. As a matter of fact, he is neither conservative nor careful; he is simply scared and stagnated and asleep in fancied security.

Some of our big mining organizations bemoan the fact that out of so many thousand prospects examined by their scouts only one or two get by as mines. That even one or two do get to the finals is the wonder, in the light of the knowledge and experience of the average scout.

There is a common and pernicious error in the attitude toward scouting, which I think is reflected in results—instead of comparatively inexperienced men, those selected for such jobs ought to be among the most experienced and best, not only from the technical viewpoint but as business men also.

Mining sense, to which Mr. Cragoe refers, or mining knowledge and moral courage, as Mr. Emmens puts it, and tempered imagination and optimism, as I make bold to say, all are necessary to the man who would recommend a prospect in the hope that it might reasonably develop into a mine. WESTERNER.

Duluth, Minn.

Consultation

Lowest-Cost Copper Producer

"What copper company in the United States has the best record for low operating costs?"

This is a question to which it is difficult to give an unqualified answer. Does the correspondent mean per pound of copper or per ton of ore? Another difficulty arises from the absence of any uniform method of reporting costs. Also, the practice of deducting credits for silver and gold produced from the per-pound cost of copper introduces complicating factors. On the face of their reports for 1926, Utah Copper, Miami Copper, and Magma Copper show costs as follows: Magma, 7.903c.; Utah, 7.94c.; Miami, 10.625c.

However, to make these data comprehensible, considerable comment is necessary. The Magma figure is the net cost of marketable copper after deducting credits for gold and silver, but before deducting any allowance for depreciation or federal taxes. State and county taxes amounting to about 0.7c. per pound of copper and all other fixed and general charges are included. The company produced, however, 860,000 oz. of silver and 9,000 oz. of gold in 1926, having an approximate value of $710,000, or 2.4c. per pound of copper. If this be added to the reported cost the revised figure is 10.303c.

Utah's cost figure includes depreciation of plant and equipment and all fixed and general expenses. Also, a credit of 1.36c. is allowed for gold and silver and miscellaneous earnings. If this be added, the cost becomes 9.30c. However, depreciation and federal taxes amount to about 1.14c. per pound of copper, so that to get a figure comparable with that of Magma a deduction should be made, bringing, as a result, 8.16c., against 10.303 for Magma.

The reason for mentioning Miami is the remarkable record for low per-ton costs for mining and concentrating. The company recovered as concentrate 15.027 lb. of copper per ton of ore, whereas Utah recovered 17.58 lb. Miami had a larger unit "smelting-marketing" cost and this, together with the smaller recovery per ton of ore, resulted in the higher cost per pound of copper produced. However, Miami, mining by block caving, and Utah "steam" shoveling with electric shovels, report the following remarkable operating costs:

Company	Miami	Utah
Per Ton Ore:		
Mining	$0.3709	$0.3139
Transportation	Nil	0.1019
Milling	0.4905	0.4843
Total	$0.8614	$0.9001
Per Pound Copper:		
Total	$0.0573	$0.0513

From the above it is apparent that ignoring the cost of transportation (an item which for Miami is nil because the mill is at the mine shaft) Utah has slightly lower per-ton costs. Also, it appears that Utah has a lower actual operating cost per pound of copper produced, although this would not be the case if the Miami ore did not yield a smaller quantity of copper per ton.

Uses of Selenium in Rubber Industry

"Can you tell me what are the most recent developments in the use of selenium in the rubber manufacturing industry? Also what the current price and rate of production may be?"

Selenium can be used in the vulcanizing of rubber to good advantage from a technical standpoint. However, economic factors prevent its use for this purpose in a commercial way. There are no selenium mines. The current supply is a byproduct of the electrolytic copper refining and the making of sulphuric acid from pyrite. The output for the year 1926 was approximately 250,000 lb. It is estimated that upward of four times this amount would be required to meet the requirements of the automobile-tire manufacturers in the United States. It is possible that an increase in price from the average of about $1.80—as prevailed during 1926—would stimulate production to some extent. However, authorities who have studied the subject feel certain that a price that would stimulate output to an extent sufficient to supply the demands of the bulk of rubber manufacturers would be far beyond the range of practicality. Indeed, it is doubtful whether the world could supply rubber manufacturers if the needs are anything like those suggested. An interesting calculation based on a comparison with gold indicates that the price would be so high as to make the use in rubber fantastic.

Chemists place selenium fortieth in the list of forty-four elements with respect to its abundance in the crust of the earth. Bismuth is thirty-ninth, and gold forty-first. The still rarer elements are bromine, tellurium, and platinum. An interesting comparison shows that the annual production of gold is about 1,600,000 lb. troy, worth about $250 per pound. This apparently is the capacity of the world to produce at this price. In a general way this suggests the possible supply of selenium at a given price; or the theoretical price that would have to be paid to stimulate a production of approximately 1,600,000 lb.

The principal use of selenium is in the glass industry. The addition of selenium to the molten glass mixture eliminates the green color due to the presence of iron. In Germany selenium is used in the making of dyes, and shipments of some consequence have been made from the United States during the past years.

Incidentally, about 900 lb. of metallic tellurium, companion element to selenium, was produced for experimental use during 1926.

Rubber Tube-Mill Liners

"What success has been experienced with rubber tube-mill liners?"

We understand that more rubber liners are used in the cement industry than in mining, though quite a number of ore-treating plants are equipped in whole or in part with rubber lined mills. Further improvements in the methods of holding the liners in place are being made, and their use should continue to become wider.

News of the Week

Summary

TARIFF DISCUSSION at the Cleveland meeting of the American Institute of Mining and Metallurgical Engineers attracted attention at Washington, because of the fact that tariff legislation is to be considered at the forthcoming session of Congress. With a Presidential election not so far ahead, only those changes in the tariff laws for which there is a wide demand will most probably be considered.

Fluorspar interests point out that the declared value on the commodity when imported varies at the different ports; these interests state that the practice has been adopted in order to equalize freight rates.

A new consolidation in the Joplin-Miami district involves holdings of the Barnsdall Zinc Co., Butte-Kansas Mining Co., and the Acme Mining Co. The properties, which are situated in what is known as the Waco, Mo., field, are said to have been purchased by New York City banking interests.

Refunds of duty are being paid on such commodities as manganese, fluorspar, and magnesite. The action is based on the interpretation that any imported article used in the manufacture of an export carries duty refund rights.

The Cloudman bill carrying an appropriation of $200,000 for the investigation and purchase of dam sites passed the Assembly of the California Legislature on April 18 by a 43 to 28 vote.

Operations at the lead-zinc deposits in the Sudbury district continue to be encouraging.

The fatal accident rate on the Rand for 1926 was 2.29 per 1,000. Falls of ground caused the greatest number of accidents, accounting for 865 non-fatal accidents and 176 fatal accidents.

A large blast on the Marquette Range yields 150,000 tons of ore; 42,768 lb. of gelatin dynamite was used in firing the 69 holes charged.

Canada as a Copper Producer

Five Per Cent of 1926 World Production of the Metal Was of Canadian Origin—British Columbia Holds Province Record for Output Now—Quebec's Future Promising

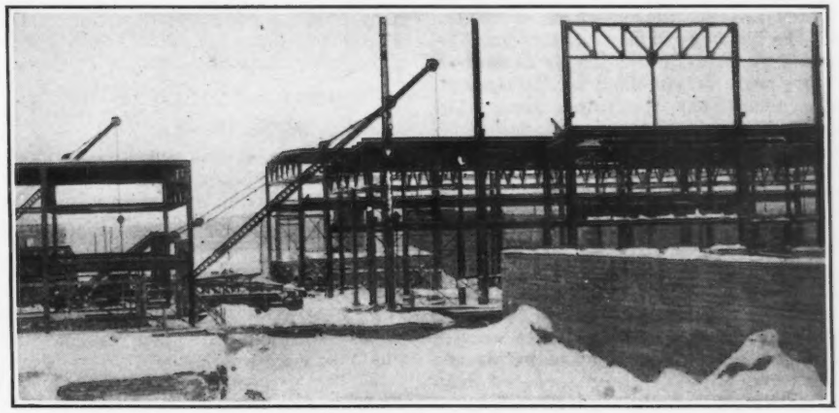
A COMPREHENSIVE report of copper-mining conditions in Canada has just been prepared by A. H. A. Robinson, of the federal department of mines of Canada. The report shows that of an estimated world output of 1,658,000 tons of copper in 1926, Canada contributed about 70,000 tons, or 5 per cent. A little more than two-thirds of the Canadian output comes from British Columbia; most of the remainder from the nickel-copper mines at Sudbury, Ontario, and a small amount from the eastern townships in southern Quebec.

Practically all the British Columbia copper is derived from three large mines, operating on immense low-grade deposits of disseminated copper sulphides, to which a small additional value is given by accompanying gold and silver. These, in the order of production, are the Hidden Creek mine of the Granby Consolidated Mining, Smelting & Power Co., Ltd., at Anyox, in northern British Columbia; the Britannia mine, at Britannia Beach, on Howe Sound, about 28 miles north of Vancouver; and the Allenby mine, on Allenby Mountain, near Princeton, in the southern interior portion of the province. The annual production of copper from these properties now approximates 45,000 tons. It is expected that this figure will be increased in 1927. In Ontario, production of copper in 1926 was about 20,656 tons, but, as practically all of this output is obtained as a by-product of the Sudbury nickel industry, production rises and falls with that of nickel.

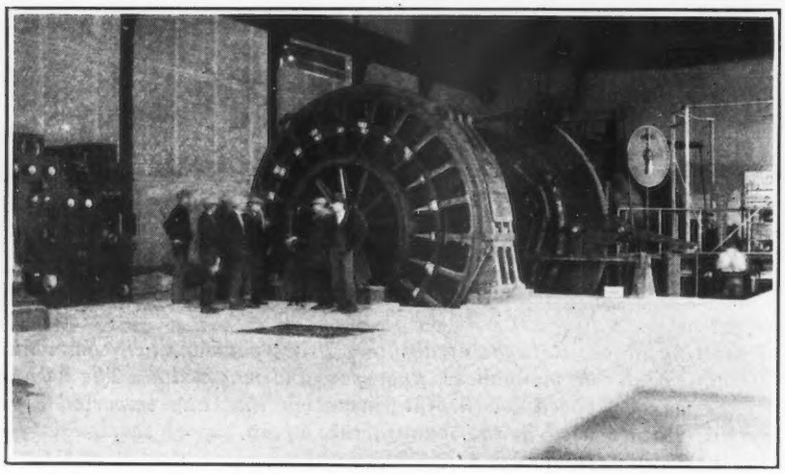
In the Province of Quebec the present small output of copper is derived entirely from cupriferous pyrites deposits that have been worked for many years in the eastern townships. The copper is recovered in the form of concentrates that are exported for treatment. It is by no means impossible, however, that Quebec may within the next few years rank next to British Columbia in Canadian copper production. Large deposits of very rich copper-gold ore have been developed in the vicinity of Rouyn in the northwestern part of the province.

At this location the Horne Copper Corporation has erected a well-designed smelter embodying the latest developments in copper smelting and ore handling. Brick, steel, and reinforced concrete construction has been used. The equipment includes a coal crusher, seven Wedge furnaces, two converters, and a Cottrell dust precipitator.

Manitoba is also likely to become an important producer of copper in the future. The existence of large bodies of mixed copper and zinc sulphides is known to occur at Flin Flon Lake and at other places in the vicinity of The Pas. The difficulty of making an eco-



The Horne Copper Corporation smelter at Rouyn, Quebec, during the construction period



The new hoist installation at the Belmont mine of the Anaconda Copper Mining Co. at Butte, Mont.

nomical separation of the copper and zinc, as well as the low grade of the ore and the remote situation of the deposits, has so far hindered development of these deposits. These problems, however, seem likely to be soon overcome, especially since the small pilot plant for the treatment of Flin Flon ore was put in operation.

Wilke Township, in the Larder Lake mining division of northern Ontario, is now claiming the attention of prospectors in search of copper. Rumors that Hollinger has taken an option on a group of claims have started a staking bee in the township. Recently samples from this region assayed 4.6 per cent copper and 40c. in gold. Wilke Township is about four miles northeast of Matheson, and about sixteen miles west of the Potter-Doal copper property. The country in that region is practically clear of bush, making it easily accessible.

Decision in Dwight & Lloyd-John E. Greenawalt Suit

Judge Thacher, in the Southern District of New York, has handed down his opinion in the suit brought by the Dwight & Lloyd Sintering Co. against John E. Greenawalt. The suit was brought on nine patents owned by the Dwight & Lloyd Co. The court held that the delay in bringing suit prevented any recovery of damages against Greenawalt as to the early patents and that proof of infringement as to one of the patents was not satisfactory, and as a result the bill was dismissed.

A counter claim filed by Greenawalt was decided at the same time. The court followed the prior decisions of the Court of Appeals of the District of Columbia and of the Ninth Circuit and dismissed Greenawalt's claim.

West Gold Mining & Milling to Erect Mill

The West Gold Mining & Milling Co., of Idaho Spring, Colo., plans to erect a milling plant on Chicago Creek. At the Sylvanite mine a large force of men is working, and the operators expect to increase this number as soon as the mill is put in operation.

New Hoist Installation at Belmont Shaft

The first of three new installations of hoisting equipment which the Anaconda Copper Mining Co. is making at Butte, Mont., was recently completed at the Belmont mine.. The new hoist is a 4,500-hp. electric type capable of operating to a depth of 5,100 ft. The four-compartment shaft of this mine is one of the largest in the district.

Harmony Mines Co. Considering Larger Scale Operations

The Harmony Mines Co., Salmon, Idaho, operating a copper mine and mill at the head of Withington Creek, in the Eldorado district, 8 miles from the nearest railroad point, is producing about 180 tons of 5 per cent copper ore daily, which is concentrated by tabling and flotation. Most of the mineral is chalcopyrite. Earl F. Nieman, vice-president and general manager of the property, was in New York last week, and advises that the installation of sintering equipment, together with a small blast furnace, is being considered. It may also be advisable to make a substantial increase in the output at the property. Until now, the concentrate has been shipped to a custom smelter, but, in view of the long transportation, it is felt that a more economical method of procedure may be found. The concentrate averages about 20 per cent copper and between 30 and 35 per cent of sulphur.

Property in Patagonia District Sells for $75,000

Announcement has been made of the sale of the Exposed Reef mine, in the Patagonia district of Arizona, to Wilson, Welty, and associates, for $75,000. A payment of 10 per cent, or $7,500, is reported to have been made when the negotiations were consummated. The mineralized zone of this district is said to have a length of 25 miles and a width of 10 miles.

Strikes of ore in the Big Jim and other properties in the vicinity have given the district considerable publicity recently.

New Operations and Property Transfers in Montana

After operating the East Pacific property, 5 miles from Winston, Mont., on a bond and lease for over a year, the Montana-Idaho Copper Co. has purchased the property for a consideration said to have been $60,000. E. J. Gibson, broker and mining man of Spokane, Wash., and C. H. Goodsell, of Spokane, manager of the company, were instrumental in putting through the deal. The property, which has produced $1,500,000, was opened in 1883 by Winston Brothers and later sold to Robert A. Bell. From 1906 until the present owners took charge the property was idle. Montana-Idaho Copper Co. has uncovered large rich orebodies below the old workings, and has been shipping intermittently for the past year. The last two cars shipped averaged 50 per cent lead, 50 oz. silver, and $3 to $10 in gold per ton. The company is now sinking from No. 6 and No. 7 levels. When this work is completed shipments will be resumed. It also is planned to build a 100-ton concentration and flotation plant. At present the company is constructing a $25,000 power plant on Beaver Creek, two miles west of the mine.

Butte Duluth Mining Co.'s property will be foreclosed and sold for the benefit of creditors. The property, consisting of seven mining claims and surface buildings near Columbia Gardens, east of the East Butte property, has been in the hands of a receiver for many years. Before the war the company built a leaching plant, which did not prove profitable. The ore is copper carbonate and silicate.

According to Glenn Anderson, manager of the Otisco Mining Co., controlled by Lewisohn interests, a 2-ft. vein which has been encountered at a point about 400 ft. northeast of the shaft on the lower level, assays over 20 per cent zinc. The property is in the south central portion of Butte.

Butte Hill Copper Mining Co. has opened a body of high-grade lead ore on the 100 level, which is located south of the shaft and assays 35 per cent lead and 18 oz. of silver per ton. On the 500 level the company is continuing its crosscut to the north. It also has drifted for a distance of over 300 ft. on the 6-ft. vein encountered 240 ft. north of the shaft.

According to advices from the Bitter Root Valley, Mont., the Mammoth company is contemplating the installation of two dredges on Hughes Creek, where the company owns extensive placer holdings. Fred Minnick, of Seattle, is manager.

North Butte Mining Co., according to report given out by Paul Gow, manager, shipped 107 cars of ore from lessees' workings of its "hill" properties last month. About 60 per cent of the amount of ore shipped was zinc, the remainder being copper ore.

John H. Cole, of Philipsburg, William D. Mayoring and Richard C. Jones, of Chicago, Harold Pempellie, of Oswego, N. Y., and Ruth Christianson, of Anaconda, have formed the Domestic Manganese & Development Co., with a capital of $25,000 and principal office at Anaconda, Mont.

Michigan Copper District Operations Expand

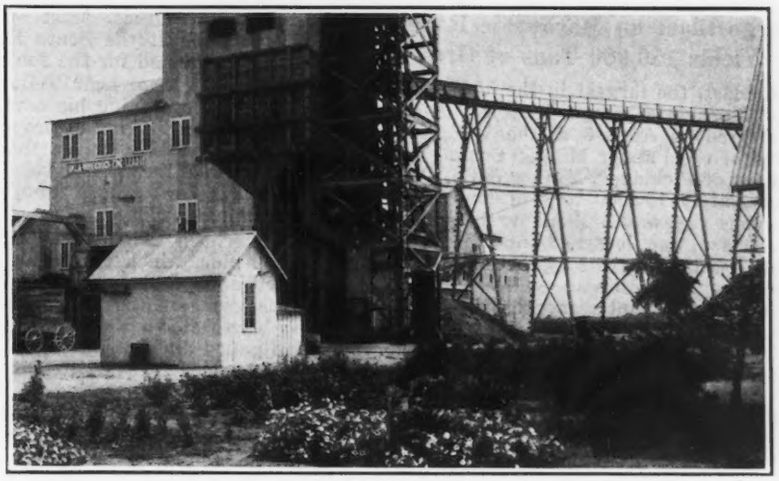
Cliff Mine Reopened by Calumet & Hecla—Seneca Working 60 Drills—Fire at No. 4 C. & H. Shafthouse

Unwatering of the Avery shaft at the old Cliff mine in Keweenaw County, Mich., which will be reopened by Calumet & Hecla Consolidated for exploratory purposes, has reached the 1,000 level. The shaft is about 1,600 ft. in depth. The Avery is the newest shaft on the property and has been found to be in good condition. None of the other shafts will be used in the exploratory program.

When the Cliff fissure was worked, a series of regular veins was cut, but none of these lodes was opened. The course of procedure of the proposed exploratory work has not been announced, but the depth of the Avery shaft provides an opportunity for thorough investigation. No work has yet been done on the Phœnix property, which is under option from the Keweenaw Copper Co., but it is planned to unwater the old fissure workings this year and conduct explorations similar to those at Cliff. It is also planned to carry the work through an extensive stretch of country, if the results at Cliff and Phœnix are of encouraging character. Extensions of a power line from Ahmeek to Cliff will enable the company to operate the exploratory plants economically. The Keweenaw Central Railroad, which is under option and will serve the properties, is undergoing repairs, and the roadbed will be placed in first-class condition.

The Seneca mine expects to bring production up to 1,800 tons of copper rock daily within a short time. Sixty drills are being used, but completion of a new compressor will permit the use of 25 to 30 additional drills. Work has been stopped in the third level drift north of No. 2 shaft. Good ground has been exposed in this opening, which will be pushed farther north at a later date. Opening of the new eighth level drifts is about to start in No. 1 shaft.

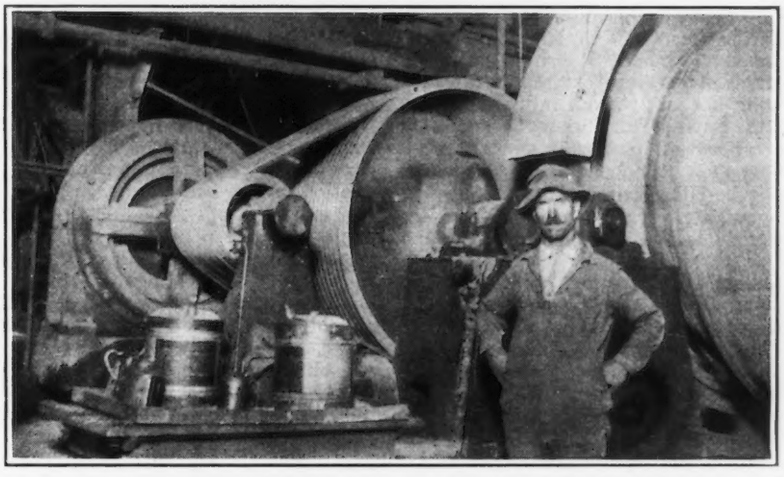
No. 4 shaft of Calumet & Hecla Consolidated, at Calumet, Mich., recently was damaged by fire, which was caused by a spark from a locomotive. Thirty-five men employed in the shaft made their way out through No. 5 shaft. Mining operations probably will continue while the shafthouse is undergoing repairs. A large tonnage of good ore, principally from backs of stopes and pillars, remains to be taken out of No. 4. The shaft eventually will be abandoned above the 80th level, but below that level it will be continued as the main producing shaft of the Calumet branch of the conglomerate department. An electric hoist is being installed at the 78th level for these operations. The rock will be trammed through the 80th level haulageway to the Red Jacket shaft.



The 1926 flower garden at the Oklahoma Woodchuck mine, in the Joplin-Miami district

Cloudman Bill Passes 43 to 28 In California Assembly

The Cloudman bill carrying an appropriation of $200,000 for the investigation of dam sites and purchase of such sites for débris-restraining purposes passed the Assembly of the California Legislature on April 18 by a vote of 43 to 28. The bill has for its purpose the paving of the way toward a resumption of hydraulic mining upon a limited scale. Whether the bill will pass the Senate and win approval by the Governor remains to be seen. Considerable opposition is being aroused.



The rope drive adapted to a ball mill at the Combined Metals Reduction Co. mill at Bauer, Utah

The Mine Beautiful

With the approach of warm weather many of the Joplin-Miami district field men turn their thoughts garden-ward. Considerable interest was taken last year in the flower-garden prize contest, and from present indications the race for the prizes this year will be even keener. The accompanying photograph shows a portion of one of the 1926 prize winners.

Control of Ducktown Chemical & Iron Co. Purchased by Copper Pyrites Corporation

Control of the Ducktown Chemical & Iron Co. has been acquired by the Copper Pyrites Corporation. This control, together with its rights on the school property, has been transferred by the Copper Pyrites Corporation to a new corporation, organized under the laws of Delaware, known as the Ducktown Pyrites Corporation. William Young Westervelt, president of the Copper Pyrites Corporation, has been elected president of both the Ducktown Chemical & Iron Co. and the Ducktown Pyrites Corporation. F. M. Kirby, A. P. Kirby, and William Young Westervelt, of the latter board, have been elected to the board of directors of the Ducktown Chemical & Iron Co.

Operations will be continued as heretofore under the name of the Ducktown Chemical & Iron Co., the offices of which company are at Isabella, Tenn. The local organization will also continue as heretofore under the vice-president and general manager, W. F. Lamoreaux.

Combined Metals Mill at Bauer, Utah

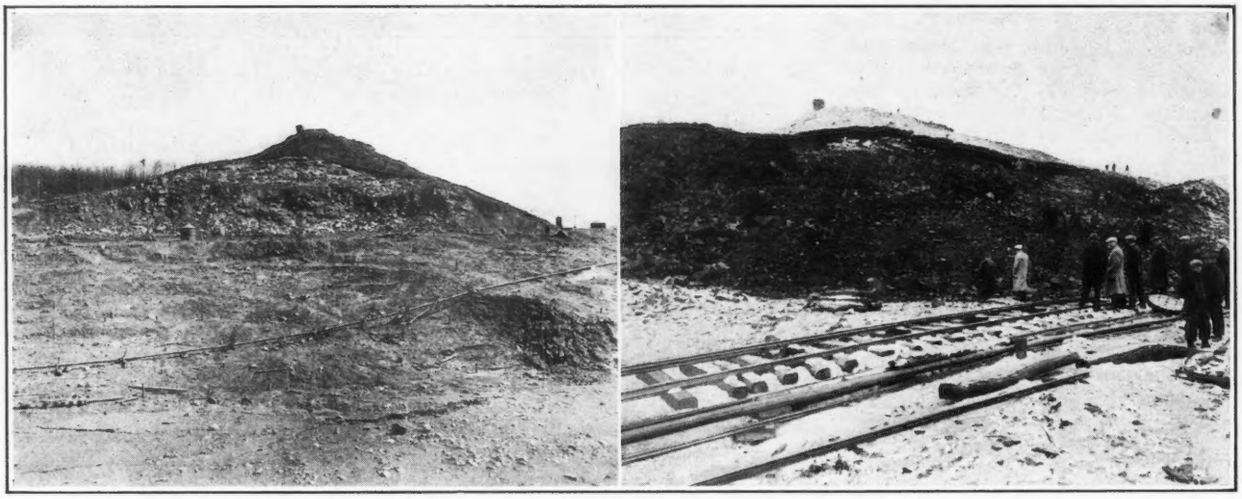
The remodeled mill of the Combined Metals Reduction Co., located in the Rush Valley district of Tooele County, at Bauer, Utah, has apparently proved successful. Milling equipment, aside from the process used, includes many of the latest mechanical features. The company's property at Bauer consists of 50 lead-silver claims, which are being developed from a 1,300-ft. shaft.

Large Blast on Marquette Range Yields 150,000 Tons of Ore

A blast, the largest in the history of the Marquette range iron-ore fields, was fired on April 8 at the Volunteer mine of the Palmer Mining Co., a subsidiary of Picklands, Mather & Co. Approximately 150,000 tons of low-grade siliceous ore was broken by the blast. The mass was loosened, and lifted a short distance, with practically no scattering of the ore.

During the winter months the company put down about 300 6-in. churn-drill holes on the north end of the property. In the above-described blast 69 of these holes, spaced 15 ft. by 20 ft., and varying in depth from 60 ft. to 90 ft., were charged with 42,768 lb. of gelatin dynamite. The bottom of each outside hole contained 100 lb. of 80 per cent gelatin dynamite; 60 per cent gelatin dynamite was used for the remainder of the charges.

The blast is said to have been very satisfactory, as it will not be necessary to block-hole any of the ore broken. All of it can be handled by the 300-ton steam shovels used, and will pass the 40-in. opening feeding the crusher. The 400,000 tons to be mined this year will be broken by similar blasts.



Left—Volunteer mine of the Palmer Mining Co. on the Marquette Range prior to a blast which produced 150,000 tons of well broken ore. Right—After the blast

Many New Ventures in Colorado —Use of Flotation Increases

The San Bernardo property, at Matterhorn, in the Ophir (Colo.) district, after a thorough repairing of all the mine property and buildings, is again producing and making some shipments to its mill. Last February snow slides swept away most of the mine buildings and wrecked the portal. Otto Beselack, the manager, immediately started reconstruction work and also installed considerable new machinery.

In the eastern part of the Mineral Hill district, near Colorado Springs, William Gasson, of Colorado Springs, has taken over the South Burns and the Santa Rita mines. The Santa Rita is being extensively worked and the re-timbering of the 200 ft. shaft has been started. It is planned to install electric surface equipment while the shaft is being repaired. Most of the development work at the South Burns mine has been planned for the summer.

In the Ophir group, near Telluride, C. R. Wilfley is continuing his development work at the Silver Bell property. A raise which is being driven to connect the 6th and the 14th levels will open up much new ground and give better tramming facilities.

The Matterhorn Mining & Milling Co., of Telluride, which two years ago reorganized and purchased the Butterfly-Terrible group in the Telluride district, has been following a conservative expansion policy and has developed the Butterfly property to some extent. A power plant has been added to this property, and the erection of a modern milling plant is now under consideration.

The Wellington Mines Co., with offices at Breckenridge, is installing a selective flotation plant for the concentration of its sulphide ores. Washington Mines Co. has been organized to operate the Washington group of lode and placer mines situated on Nigger Hill and in the Illinois Gulch in the Breckenridge district. The company is planning to erect a modern selective flotation plant.

Colorado Zinc has been so successful with its flotation mill that the directors are now considering increasing the daily capacity from 250 to 500 tons. It is planned to install the new unit this spring. According to a report the Ibex Mining Co. will build a mill this spring at its Little Jonny mine to treat the large body of low-grade ore available.

The East Seventh Mining Co., operating the Hibschle shaft, opened a large body of high-grade lead in one of the lower levels. On account of the weather the recently opened workings were abandoned. Operations are being carried on in the upper workings, and a fair grade of ore is being shipped.

The Turinde Mining & Milling Co., of which Lee Wood is president, with offices in the Thatcher Building, Pueblo, is reported to have opened up a rich body of ore, containing gold, silver and copper, in the 200-ft. drift of the company's Independence mine at Turret, Chaffee County, last week. Samples have been sent to Denver for assays.

London Letter

By W. A. Doman
Special Correspondent

Ferromanganese Interests Under New Direction—Minière to Erect New Plant

London, April 12—Last November I made reference to a circular issued by the Central Provinces Manganese Ore Co., Ltd. Information then given was supplemented at last week's meeting of shareholders, and the reason for the amalgamation was stated. The chairman said that the supply of manganese ore suitable for making ferro-manganese was a matter of concern to British steel makers, as the deposits in the Caucasus, Nicopol, West Africa, and Brazil were not under British control, and as the only other available supply of any importance was from India. Mines owned by the Central Provinces Manganese Ore Co., Ltd., are the most important in the country. That company has secured an outlet for a considerable part of its production, and has, to an important extent, consolidated its interests with a number of ferromanganese makers, who have taken supplies of the company's ore for many years. The new company is under the direction of two representatives approved by the ferromanganese makers, and two approved by the Central Provinces Manganese Ore Co. The board of the last-named company is of the opinion that the production of ferromanganese in this country is now on a sound and profitable basis.

At the annual meeting of the Champion Reef Gold Mines of India, the chairman said that the end of July should see the new shaft in working order, and that the company was approaching a new period in the working of the mine. Since the last reconstruction, six years ago, two phases had been passed through: for the first three years there was little or no payable ore in the bottom of the mine; during the next three years plenty of rich ore was being opened up at the bottom,

but the hauling capacity was inadequate. "Once this shaft is in working order," said the chairman, "we shall be entering a new period, I trust, of considerable prosperity."

A cablegram from Allahabad states that a mineral survey of Kashmir and Jammu, made by C. S. Middlemiss, has located large deposits of coal, bauxite, copper, zinc, iron, talc, and china clay.

The £1 shares of the Government Gold Mining Areas (East Rand) have risen to 9 3/16s.; they are now to be split into 5s. shares. A price of £2 10s. per share is predicted for them.

Notwithstanding the decline in the prices of lead and spelter, the profits of the San Francisco Mines of Mexico have continued to expand, those for March amounting to £37,423, which is an increase of £8,000 over the February figures. For the six months of the company's year, the profits have risen from £61,000 to £223,000.

It is reported that Sir Abe Bailey is negotiating to purchase the interest of H. G. Latilla in the Rhodesia Exploration Co. The information cannot be confirmed at the moment, as Mr. Latilla has just left for South Africa.

It is stated that Union Minière will at the end of next year have in operation its new lixiviation works at Panda (Katanga), which will be able to produce 30,000 tons of electrolytic copper annually, and that the output of the works is to be gradually increased. The Union Minière company also plans to erect a sulphuric acid plant to be operated by a subsidiary company; the plant will require a capital of about 60,000,000 francs.

Another Consolidation Occurs in the Joplin-Miami District

Barnsdall Zinc, Butte-Kansas, and Acme Companies Involved in Deal—$50,000 Offers for Tailing Piles

More than a million dollars is involved in the projected sale and consolidation of three mining concerns in the Joplin-Miami district. Completion of the deal it is expected will be announced before May 1. The concerns involved are the Barnsdall Zinc Co., the Butte-Kansas Mining Co., and the Acme Mining Co. It is reported that the prospective purchaser is a combination of banking houses of New York, which has been represented in the Joplin-Miami field recently by Theodore Gross. The properties include five concentrating plants and five operating mines. They have been under option to Gross for several months.

The Barnsdall Zinc Co. is a subsidiary of the Barnsdall Corporation, and is managed locally by P. B. Butler, of Joplin. The Butte-Kansas is owned principally by L. P. Buchanan, of Joplin. This concern represents the largest property in the projected consolidation, and, it is understood, will be sold for approximately $800,000. The Butte-Kansas mines have shipped 8,500 tons of zinc ore, valued at around $400,000, in the first fifteen weeks of 1927. All the properties are in the Waco, Mo., field, northwest of Joplin, most of them just across the state line in Kansas. The Acme lease consists of 40 acres, the Butte-Kansas of 80, and the Barnsdall of 200 acres.

This deal, which is virtually consummated, has revived rumors of other big deals in this field. It has been reported that the Commerce Mining & Royalty Co. is about to sell out to Anaconda, and that the Eagle-Picher Lead Co. is considering an offer from the American Zinc, Lead & Smelting Co.

In the old days, big tailing piles in the Joplin-Miami district were considered a liability rather than an asset. Now the situation is different. The development of flotation treatment has made tailing valuable, and some big piles in the field have brought offers of as much as $50,000.

At a recent meeting of the mine safety engineers of the Joplin-Miami field it was announced that 21 mines of the district had operated two or more consecutive months in 1927 without a single lost-time accident.

The Vantage Mining Co. is planning to expend about $25,000 on improving its No. 1 mill in the Joplin-Miami field. A new flotation plant is to be added, and a new surface tram will be built between the mill and the two south field shafts.

News From Washington

By PAUL WOOTON
Special Correspondent

Cleveland A.I.M.E. Tariff Views of Much Interest —Fluorspar Import Values Questioned

MUCH INTEREST is being manifested in Washington in the discussion which took place at the Cleveland meeting of the American Institute of Mining and Metallurgical Engineers. Any event which has a bearing on the tariff comes in for unusual attention at this time, as tariff legislation is certain to be considered at the forthcoming session of Congress.

It is true that the majority leaders in Congress plan to put a strict limit on tariff matters which will be given right of way, but the minority is equally determined to undertake a more general revision. The probabilities are that neither side will attain its full objective, with the result that only those changes in the law which are in wide demand will be considered. With a Presidential election in the offing, majority opposition will be confined to the features of the tariff act which can be defended.

Note has been taken of the strong sentiment manifested at the Cleveland meeting against duties which benefit only a few and which hold no promise of building up production sufficient to take care of more than a fraction of domestic requirements. In the case of certain of the mineral commodities there also is involved the question of depleting reserves which are essential to the national defense—another matter in which Congress has primary responsibility.

Consideration of certain items of the present law probably will not be opposed by the majority when the showdown comes. They recognize that one unsound paragraph in a tariff law gives an effective talking point to the opposition and tends to undermine the whole structure. In such a situation, however, they will look to conservative, disinterested sources for information as to the items which fall into that category.

By the time Congress convenes the U. S. Tariff Commission will have ready current information as to various of the commodities which are under fire. The manganese duty and that applying to several other mineral commodities are now before the commission. The preliminary report on manganese has already been completed, it is understood. If the facts justify it, the commission, after studying the record, will call a public hearing, at which all concerned will have an opportunity to present their views.

That the declared value of imports cannot be relied upon as a true measure for the calculation of foreign costs is a point made by the domestic producers of fluorspar who are seeking an increase in duty. Declared value of fluorspar, it is pointed out, varies at different ports. Imports at New York are valued at 60c. a ton less than imports at Baltimore, and at 40c. a ton less than those brought in at Philadelphia. This practice is resorted to, it is declared, to equalize freight rates. The rates to the Central Freight Association are lower by 60c. and 40c. respectively from Baltimore and from Philadelphia than those in effect from New York to the same territory. Apparently the British producers realize that the traffic will stand that amount of additional charge, so they add the difference to the declared value of shipments to be discharged at Philadelphia and Baltimore.

It has also developed that customs drawbacks are being paid on such commodities as manganese, fluorspar, and magnesite. Heretofore the general supposition has been that the drawback applies only to an imported article being exported, or to constituents of exported articles on which duty has been paid; the law, however, does provide for the refund of duty on any imported article used in the manufacture of an export. In the case of manganese only a part goes into a finished metal, since some of it stays in the slag.

Refunds, however, are being allowed on all manganese used in the manufacture of metals for export. In the case of fluorspar no part of it becomes a part of a finished metal; and magnesite is used simply as a refractory in the metallurgical furnaces. When this provision of the law is more fully understood it is believed the total annual amount of drawbacks paid will increase materially.

Toronto Letter

By Our Special Correspondent for Northern Ontario

Rich Ore Find Reported at Frood Mine—Sudbury Lead-Zinc Operations Promising

Reports of rich copper ore at depth in the Frood mine of the International Nickel Co. has stimulated public interest and resulted in stock-market activity causing an increase in the share value of about $15 in a little over two weeks. It is reported that this ore was encountered by diamond drills at depths of about 2,000 ft., and reports are current regarding assays as high as 8 per cent over widths of 200 ft. Partial confirmation of this is given by the report of President Stanley that copper ore has been found of sufficiently high grade to justify the company in treating it separately. It will of course be some time before this can be done, as about a year will elapse before the new shaft is completed. Further time will then be required to equip and finish the shaft, carrying out the development work, and opening up the orebodies preparatory to stoping. During the interval, however, it is presumed that a new smelter installation will be made to handle this copper ore. The company plans to spend $175,000 on additions to its sintering plant. Sales of nickel continue to show a moderate increase, and earnings are reported to be at a rate somewhat higher than during the preceding year.

Operations of the Bunker Hill & Sullivan Co. on the lead-zinc deposits in the Sudbury field continue to give encouraging results. On the 300 level 800 ft. of drifting has been done, a large part of which is in ore 10 to 20 ft. wide, and parallel orebodies have been located by crosscuts and diamond drilling. The grade of the ore is understood to be approximately $20 a ton.

The drift is getting near a point where diamond drilling from the surface showed much greater widths of ore, intersections up to 100 ft. wide having been found with the drills. A new shaft will soon be started and sunk to 600 ft. The location of this shaft is several thousand feet east of the present workings, and a start will be made as soon as the plant is on the ground and more power available. A transmission line is being built from the Wahnipitae Power Co. It will soon be completed. The Federal Lead Co. is understood to have secured options on a considerable acreage, and the Dome Mines, of Porcupine, has also optioned some ground.

At the annual meeting of the Howey Gold Mines, of Red Lake, the directors were re-elected. The report from the mine states that a shaft has been started and is down 25 ft. Building construction is well under way, the different items being from 60 to 90 per cent completed. Plant and machinery is being installed and will be ready for service in about two weeks. A shaft will then be sunk to 500 ft., and four levels will be opened up. The company has $275,000 cash on hand and a year's supplies on the property.

At the Keeley Mines, of South Lorrain, production during March was 125,250 oz. of silver and 9,237 lb. of cobalt. A winze was sunk 77 ft. below the 11th level, the average assay being 125 oz. over 42 in. At the Canadian Lorrain property, which is controlled by the same interests as the Keeley, results have not been particularly satisfactory. Much difficulty has been experienced in opening up the stopes, and the dilution has been high. It has also been found in some places that where drifts showed commercial ore, stoping operations gave much poorer results. The report of the management hints that the mill may be closed down to await more favorable silver prices and to enable the company to concentrate its energies on further development work.

In the last few weeks there has been considerable improvement at the Cobalt Contact Mines, and operations are now said to be on a profitable basis as a result of the opening up of milling ore of considerably higher grade. Mill heads at present are running about 35 oz. a ton, and indications point to this grade being maintained for some months. The Contact recently took an option on the Ruby property for $60,000, the first payment to be made in 1928. A crosscut is being driven from the 200 level of the Contact to the Ruby shaft. The Ruby was explored by the Coniagas Mines several years ago, when a very strong cobalt vein was found and developed, but it contained very little silver.

On Oct. 13, 1926, a few days prior to the annual meeting, the directors of the Beaver Consolidated Mines of Cobalt declared a dividend consisting of 1,000,000 shares of Kirkland Lake Gold Mining Co. stock, to be distributed at the rate of one share of Kirkland Lake for each two shares of Beaver. At the annual meeting a new board of directors was elected, and their first action was to rescind the dividend. One of the shareholders applied to the courts for an order to compel the payment of the dividend, but in the decision which has just been handed down this action was dismissed. The decision appears to be of considerable importance, as it apparently establishes the fact that an incoming board of directors can rescind the dividend declaration of an outgoing board.

During March, the Vipond Mines, of Porcupine, treated 7,781 tons of ore, and recovered bullion to the value of $63,200, an average of $8.13 a ton.

Development in the Gaspe zinc district has been held up on account of the delay in installing the compressor.

Nacozari Copper Co. Sets Safety Record

The Moctezuma Copper Co., with properties at Nacozari, Mexico, operated throughout the entire thirty-one days of March without a casualty of any sort, thereby establishing a record in the no-time-lost accident campaign being conducted by the mining branches of the Phelps Dodge Corporation. Second place went to the Morenci, Arizona, branch, and third place was taken by the Copper Queen, at Bisbee.

Johannesburg Letter

By John Watson

Special Correspondent

Rand 1926 Fatal Accident Rate 2.29 per 1,000—To Increase Manganese Production

Johannesburg, March 22—The accident death rate of the Rand gold mines for 1926 was 2.29 per 1,000. This figure closely approaches the record low figure of 2.28 per 1,000 for 1921. Total deaths due to explosives show a gratifying decrease to 71 for the year 1926; in 1925 there were 112 such accidents, and in 1924 there were 88. The largest number of accidents were due to falls of ground. There were 865 injured and 176 killed in accidents due to this cause. Among the individual producing mines Modder Deep had the lowest death rate for 1926, 0.80 per 1,000; Langlaagte Estates was next, with 0.88 per 1,000; New Modder, 1.87 per 1,000; Van Ryn Deep had the highest rate, with 1.99 per 1,000.

A new company, Carrig Diamonds, Ltd., has declared its fifth interim dividend, this time 200 per cent, which brings the total dividend up to 400 per cent for the five months of registration. The four previous dividends were 50 per cent each.

Advance government figures published on March 17 show that the output of alluvial diamonds in western Transvaal in February totaled 190,130 carats, valued at £538,184. These figures exceed the previous high record which was made in October, 1926. Grasfontein is said to have produced many surprises. A syndicate working on J portion of that farm has recovered £6,000 worth of stones from one claim in seven weeks. At Zweme Kuil a stone of 80½ carats was found.

At the Industrial Crafts Exhibition recently held in Johannesburg one of the most notable exhibits was a plaster model of a huge gold bar, 10½ ft. long, 3½ ft. wide, and 1 ft. 7 in. deep, representing the Transvaal average gold output for one month. The model was prepared and exhibited by the Chamber of Mines.

Negotiations have been concluded with American interests by which about £250,000 will be advanced for the construction of a branch railway line to the Postmasburg manganese area. The American interests expect that thirteen trains daily will be required to handle the production.

Carson Case Decision to Be Appealed

On April 19 Federal Judge Charles M. Pray issued an order permitting appeal of the decision returned Jan. 25 at Butte by Federal Judge George M. Bourquin in the $15,000,000 patent infringment suit brought by the Carson Investment Co. and John Miller, trustee, against the Anaconda Copper Mining Co. Judge Bourquin in his verdict found for the Anaconda company. The order issued today will enable the Carson company to take the case before the United States Circuit Court of Appeals at San Francisco.

Manganese Tariff Under Fire at Cleveland

Its Removal and Purchase of Foreign Ores by Government for Storage Against Possible War Are Recommended— Other Aspects of Problem

MANGANESE is one of the minerals whose importance the World War made evident as never before. It is essential for making steel—as a deoxidizer and desulphurizer. Foreign resources had been relied upon, but when ships became scarce and the submarine menacing, attention was directed to the possibility of meeting the needs of American furnaces from domestic deposits. The Government appealed for greater production, and, in a way, guaranteed the prospective producer against loss. Thus manganese became one of the "war minerals," the others included within the relief legislation that was passed after the armistice being chrome, pyrites, and tungsten. The war over, access to foreign resources of manganese was once again unrestricted, and the domestic industry languished. Aid for it came in the form of the Tariff Act of 1922, since when the development of deposits and production of ore have made limited progress.

PUBLIC INTEREST in manganese has been practically dead, despite the fact that provision for an adequate supply of that commodity must be one of the first considerations in any program of industrial preparedness, since on it depends the steel industry. By way of arousing interest a joint effort was recently undertaken by the Ohio Section of the A.I.M.E. and the Iron and Steel Committee of that organization to make clear to the average citizen the technical aspects of the manganese problem. Under the auspices of these two bodies a meeting was held at Cleveland, Ohio, on April 19, at the Cleveland Hotel, at which the various aspects of the situation were considered.

Certain questions lying just outside of the usual technical and commercial approach to the manganese problem were raised by Dr. C. K. Leith, of the University of Wisconsin, who presided at the opening session, in an address on "Some Political Aspects of the World Manganese Situation." Manganese was one of the minerals, he said, which were principally consumed in countries other than those of origin. Of the world production nearly 85 per cent was consumed by the United States, England, Germany, and France, and a third of it by the United States alone. On the other hand, over 85 per cent came from Brazil, Russia, India, the Gold Coast, and the Sinai Peninsula. Thus it followed, he said, that practically all manganese moved across international boundaries in raw or alloy form and that the larger part of this movement was for long distances and over oceans.

There was no indication, said Dr. Leith, that any one of the principal consuming countries could develop even approximately adequate supplies of its own. Under abnormal war conditions only 35 per cent of the needs of the United States were met from local sources and under our recent tariff only 11 per cent. The known reserves of the world, however, together with highly probable extensions and explorations now under way, indicated no shortage from a world standpoint for decades to come. Furthermore, the production and marketing of manganese was going steadily into fewer and stronger hands. Over 90 per cent of the total amount mined was consumed by the steel industry, which was acquiring control of a considerable part of the production in all of the principal fields—the Germans in Nikopol, the English in India and on the Gold Coast, and the Americans in the Caucasus, India, the Gold Coast, and Brazil. Some of these companies were international in scope. Concentration of commercial control was a notable tendency. As a consequence smaller consumers throughout the world were becoming uneasy about their ultimate supplies. The sources of supply were few enough to warrant the belief that more or less monopolistic elements of control were not impossible.

The Political Aspect

On the political side, said Dr. Leith, an obvious reaction to this situation was the growing interest of governments in the question of future supplies, whether for peace or war. A large part of industrial, political, and even military power of the world centered around the three great steel-producing units, the United States, England, and Franco-German. The very existence of these units depended on their future access to the limited number of large reserves which the world had. Possibilities of monopolies were being carefully watched. When, therefore, capital associated with these industries was used to acquire commercial control of any of the principal sources, said Dr. Leith, we thought of it not merely as a commercial transaction but as something vitally affecting the prosperity of the nations in which the money originated. Likewise, in the countries of origin there was growing realization of the importance of manganese deposits shown by the tightening of government control in various ways, such, for instance, as the hard bargain driven by the Russian Government in the Georgian and Nikopol concessions, and the recent Brazilian export tax.

The manganese situation well illustrated the outward commercial and political thrust of the North Atlantic countries against the rest of the world in the development and exploitation of mineral resources, said Dr. Leith. In fact, nature's concentration of mineral deposits of proper grade, proportions, and amount in the North Atlantic countries had given these countries probably for all time the rôle of world exploiters, and chief of them was the United States. These countries had exploited the rest of the world at a constantly accelerating pace with a growth of world demand for minerals, he said. The outlying countries possessing manganese had felt and would continue to feel this pressure, and most of them yielded to it whether they liked it or not. This was inevitable and inexorable. From the American point of view, fair methods on the whole were being used, and the exploitation resulted not only to our advantage but to that of the countries being exploited, but whether this was true or not the exploitation would continue. In a way, said Dr. Leith, this was the doctrine that "might makes right," but only to the extent that might was permanently lodged by nature in certain places.

It must be clearly understood, the speaker said, that nature's distribution of sources requires international exploitation of certain minerals if our material civilization was to go forward along present lines; that whatever theoretical considerations of right or wrong were involved, the movement could not be stopped; that this movement required the open door and, in some measure, the overriding of national self-determination; that, in fact, it was a phase of economic materialism and that dollar diplomacy was involved. Until the political atmosphere was cleared on this question there was always danger of snap political action, based on temporary and local circumstances, which might go to the one extreme of forcing exploitation on other nations without regard to their legitimate rights, or to the other extreme of handicapping necessary foreign exploitation by lack of national support.

Secondly, said Dr. Leith, there was immediate opportunity for constructive effort directed toward the manner in which the exploitation was being done. Experience had shown both good and bad ways of exploitation. As the leading exploiter of the world's minerals it would seem natural to expect that sooner or later this country might formulate the principles of a policy which put mineral exploitation in proper perspective, which discriminated necessary from unnecessary exploitation, and which could be adhered to with little more consistency than had been exhibited in recent decades.

Touching on the tariff, Dr. Leith said that its purpose was not primarily to produce revenue and that it had been established beyond reasonable doubt that manganese supplies were too

limited to play any large part in the manganese industry, and that such as did exist should be reserved for times of national emergency. This being the case, he said, the tariff became merely a nuisance to the consuming industry without corresponding gain to anyone.

In view of this situation, Dr. Leith said, storage of an adequate supply of manganese for war emergency was possible, desirable, and essential. To make the United States independent for a war as long as the last one would require the storage of an immense tonnage, which could not be accomplished without its becoming generally known. This, however, for a long-continued war would only be a partial and temporary expedient. The only really adequate solution, said Dr. Leith, seemed to be control of the channels of flow from the sources. Dr. Leith did not attempt further discussion of this save to call attention to what he termed the obvious fact—namely, that combination with the British Empire would more nearly assure the safety of the far-reaching supply routes of the United States than any other thing in sight.

PREPAREDNESS THE MOTIVE, SAYS R. C. ALLEN

In the discussion that followed, R. C. Allen, vice-president of Oglebay Norton & Co.—the man chiefly responsible for the meeting, according to the chairman—said that the A.I.M.E. was not a political party and that it was not the purpose of the meeting to blow the lid off the tariff. Despite this, it was not possible to exclude this question of public policy. The Institute, however, as the Institute, was taking no position on the tariff on manganese or any other minerals. The tariff had stood for five years, said Mr. Allen, but the production of domestic manganese had been going down instead of up.

Coming to the real purpose of the meeting, Mr. Allen said that a general preparedness program should be devised in time of peace and that we should see to it that there was an adequate supply of essential minerals and commodities. Other countries had a policy to safeguard themselves, but we had none despite the recommendations of various bodies, and no step had been taken with respect to manganese and other essential minerals.

D. F. Hewett, of the U. S. Geological Survey, said that many mining men seemed to have an inadequate perspective of the industry. He pointed out that England, which at various times had led the world in the production of copper, lead, iron, and tin, had once had the same debates as were now going on here. The situation which the United States was facing in this decade was pretty much the same as that which England faced fifty, sixty, and seventy years ago. The United States was going to pass the peak of production of its important minerals in the next ten years, said Mr. Hewett. It had nothing else to do than to look forward to the production of its principal minerals from abroad.

Dr. J. S. Grasty, of Charlottesville, Va., remarked that time and money were needed to develop the manganese deposits. Those interested in domestic deposits, he said, had had the time but not the money. It seemed that we were injecting ourselves into a political problem, however much we might disavow it. He was engaged in studying an interesting occurrence of manganese in Virginia, he said. Three hundred thousand tons averaging 30 per cent Mn had been blocked out, and there was a possible 700,000 tons in addition. He intimated that the estimates of tonnage in the United States, or lack of tonnage, were misleading. The chairman interjected that the engineers who made these estimates would be the first to disclaim any finality for their figures.

Colonel Arthur S. Dwight, speaking briefly, said that it was important that there should be a united effort to protect the supplies of manganese and other strategic minerals in time of war.

The importance of manganese in the steel industry was then described by H. M. Boylston, professor of metallurgy in the Case School of Applied Science. He quoted Professor Sauveur's definition of steel, that it was an alloy of iron and carbon containing substantial amounts of manganese. In 1925, he said, 45,393,524 gross tons of steel ingots was produced in the United States. Thus it followed that 453,935 gross tons of 80 per cent manganese was needed in that year alone.

Following Dr. Boylston, a comprehensive paper on "Minnesota Manganiferous Iron Ores in Relation to the Iron and Steel Industry," by T. L. Joseph, E. P. Barrett, and C. E. Wood—all of Minneapolis—was presented by Mr. Joseph. About 75 per cent of the domestic reserves of 5 to 35 per cent manganese ores was in Minnesota. The estimate of the total domestic tonnage was from 35,000,000 to 48,000,000. Minnesota could supply the needs for high-manganese pig iron for twenty to thirty years, assuming that there would be adjustments to compensate for some decline in quality. The Cuyuna manganiferous iron ores were not readily amenable to the usual methods of beneficiation, because of the fact that the iron, manganese, and gangue were finely disseminated. A great amount of data regarding the research done on manganese and its ores in relation to making steel was included in the paper.

L. B. Miller, of Cleveland, in the discussion of the preceding paper, said that he did not object to the statement that high-grade manganese ores did not exist in the United States. However, he thought that the Bradley leaching process, sponsored by the Bradley-Fitch Co., of Minneapolis, would do much toward making low-grade ores available. Under the encouragement of the present tariff on manganese ore, he said, this process had been developed, although it had not yet been put into commercial operation. It was intended for the beneficiation of the ferruginous manganese ores of Minnesota. It was a leaching process that beneficiated oxides and carbonates of manganese. The ore to be treated was reduced to 80 mesh, and roasted at 450 deg. C, which reduced the ore to manganese monoxide or MnO. The leaching medium was a 10 per cent solution of sulphate of manganese, said Mr. Miller, which transformed the oxide of manganese to sulphate. This was treated with free ammonia, producing manganese hydroxide, which, when ignited or sintered, yielded a high-grade manganese product. Most of the oxide of iron and silica and practically all of the alumina, lime, magnesia, phosphorus, and carbonate of barium were discarded as waste. The temperature at which the ore was first roasted had been found by experiment to be the point at which the greatest amount of iron oxide could be discarded. A 95 per cent saving of the manganese could be made. This process yielded a product running 68 to 70 per cent Mn after sintering. The leaching took about two hours, when the ore was reduced to 80 mesh. Outside of metallic iron in the original ore, practically all of the impurities were insoluble in sulphate of ammonia. Results of the test on Crow Wing County ore (Cuyuna range) of the black variety showed the following:

	Original Ore	Concentrates
Iron	30.00	5.67
Silica	28.00	1.00
Mn	15.00	70.80
Phosphorus	.10	.020

Owing to the encouragement of the present tariff, a process had been developed for economic separation of the finely dividied oxides from the residual clays in the Batesville district, Arkansas. Analysis of material so recovered, he said, was as follows: Mn, 32 per cent; Fe, 18; SiO_2, 9; Al_2O_3, 4; CaO, 6; S, .025; $BaCO_3$, 3; and P, .75.

MR. REYNDERS PRESIDES

The afternoon session was presided over by J. V. W. Reynders, who also discussed manganese resources in relation to domestic consumption. After emphasizing how essential manganese was to the manufacture of steel, Mr. Reynders proceeded to catalog briefly the sources of production outside of the United States. Summarizing, he said: "The low cost of production from the four great sources, Russia, India, the Gold Coast, and Brazil, the magnitude of their reserves, their accessibility to water transportation, and their ability to expand production readily, are the factors which tend to make the mining of manganese in other sections of the world non-commercial. . . . It would seem probable that deposits of manganese other than those mentioned will be forced to remain dormant until economic exhaustion is more nearly approached by the four great sources. It must be taken into consideration that with the possible exception of the Gold Coast, a combination of two of any of the three great sources could with comparative ease supply the world's present demands of relatively 2,400,000 tons."

The position of the United States was clearly that of a consumer, said Mr. Reynders, as the known domestic resources of high-grade ore would not supply our present requirements for two years, even if all of the ore could be mined in so brief a period. In the event of a national emergency which cut off present sources of supply in whole or in part, no solution was possible save through the accumulation, in time of peace, of a reserve of for-

eign ores sufficient to tide over the needs of the Army and Navy covering the period during which the normal avenues of trade might be closed or subjected to interference.

Urges Repeal of Tariff

As for the tariff, Mr. Reynders said that the production of domestic manganese ore since the enactment of the Tariff Act of 1922 illustrated clearly and beyond dispute the erroneous theory upon which it was based. The fallacy of accepting war-time production as indicative of the ability of domestic mines to supply the country's needs in time of peace was apparent when it was realized that in order to utilize domestic production during the war, requirements as to analysis of ores had to be greatly modified and domestic production was supplemented by the importation of more than twice as much Brazilian ore.

Continuing, Mr. Reynders said that in 1926 upward of 700,000 tons of metallurgical ore was imported. Meanwhile the domestic production of metallurgical ore was but 22,400 tons, thus showing that only 3 per cent of the consumption was supplied by domestic mines. In this same year nearly $8,000,000 was paid to the United States customs by the American consumers of manganese in order that the domestic production might be 22,400 tons. Thus, he said, the public at large was taxed to the extent of $360 per ton of ore having a sales value of only $31 per ton.

It was obvious, said Mr. Reynders in conclusion, that the existing tariff on manganese should be repealed. Furthermore, the United States Government should accumulate over a period of years such a stock of manganese ore of standard grade and analysis as would meet the needs of the War and Navy departments should the national security ever be placed in jeopardy. The market value of this entire manganese ore supply, to be acquired in from six to nine years, was but $12,000,000, and its effect would be to safeguard the quality of all steel that might be needed in a period of emergency lasting one or two years. It had been suggested, he said, that the government might acquire this supply of ore in a "painless" way by requiring that the import duty be partly paid "in kind"—that is to say, in ore.

Opposition Voices Itself

A. G. Betts, of Kinderhook, N. Y., presented a written discussion of Mr. Reynders' paper in which he defended the tariff on manganese, and said that if allowed to remain it would finally result in this country becoming independent with respect to manganese.

Following him, J. Carson Adkerson, consulting engineer, who was interested in a mining operation at Woodstock, Va., stated that the meeting was governed by persons whose sympathies rested in foreign manganese fields and that all speakers on the program were known to have viewed American manganese through smoked glasses. Manganiferous iron ore was very interestingly and fully discussed, but not a single representative of domestic manganese was scheduled to present facts about American manganese ores, he said.

American manganese was in its infancy, said Mr. Adkerson, and combined pressure of foreign interests could not stop the steadily increasing production from American fields. Mr. Reynders had given 1,493,200 tons as the total minimum possible reserve of 35 per cent plus metallic manganese ore in the United States which could be produced at $50 per ton index price, the speaker said, but he had failed to give weight to the fact that considerably more than 1,493,200 tons of this grade ore had already been shipped from American mines at an average price of, say, $33 per ton. Mr. Reynders had stated that shipments depleted reserves of the figure named, but he had failed to show that, while shipments continued, the admitted estimated reserves were increasing year by year and that recent developments in Virginia and Montana alone had increased the estimated reserves in figures of several hundred thousand tons. The deposits in America had hardly been scratched, but they had shipped more than 1,493,200 tons, said Mr. Adkerson. Any estimate of reserve, until the ore were tested or blocked out, was a guess, he said, but his fifteen years of engineering research, development and operation in manganese in the United States had demonstrated to him that it was sensible to estimate that not more than one-tenth of the reserve of the United States had been shipped. This meant that the total minimum possible reserve of the United States could better be estimated at 14,932,000 tons.

The previous speaker, Mr. Adkerson said, had called attention to the fact that $31.20 per ton, including duty, was being paid for foreign ore at the ports, but he had failed to explain that most American producers were being offered and paid from $5 to $10 per ton less for the same grade of ore and under the same schedule of analysis.

Mr. Reynders had given prominence to the statement that the annual production since the tariff was only 22,400 tons, he said, but had failed to account for the record of 1925 alone, which showed 98,324 tons shipped from domestic properties during the year.

The tariff followed a firm principle and was justified, said Mr. Adkerson. It brought to the government an income of $8,000,000 a year and promoted the development of an essential industry which had grown from almost nothing in 1922 to production at the rate of more than $3,000,000 per year in 1927. Instead of developing our own reserves it had been suggested, however, that the government go into foreign fields and buy $12,000,000 worth of ore and store it. This carried with it an annual cost of around $700,000 per year, the speaker said.

Furthermore, there had been shipped from mines in the United States a total tonnage of ore containing 5 to 35 per cent manganese, amounting to 13,741,959 tons, and this tonnage was constantly increasing, Mr. Adkerson said. The full and complete records of the shipments and developments of American manganese for the years 1926, 1927, and 1928 would help clear the glasses of impartial observers.

D. F. Hewett, further continuing his impromptu discussion of the morning, though also with reference to Mr. Adkerson's statements, said that a more definite impression of the nature of mineral reserves, as well as of those portions which we called ore, might be obtained if one visualized a pyramid or cone, broad at the base and tapering to a point upward, but divided horizontally into a series of zones of equal thickness representing grades of material expressed either by range of per cent of a certain metal or its value in dollars per ton. Thus, in the case of iron-bearing material, one might imagine such a pyramid capped by a block of a certain size representing the quantity ranging from 60 to 70 per cent iron. The area of the base was proportional to the tons in reserve. The nature of iron-bearing deposits was such that there was a much larger block of materials containing 50 to 60 per cent of iron—say ten times. If material ranging from 40 to 50 per cent was considered, Mr. Hewett said, the chances were that the quantity was still larger—say even ten times that ranging from 50 to 60 per cent. Continuing downward to the zone representing that ranging from 0 to 10 per cent iron, it would include all of the crust of the earth not segregated in the higher layers, for the crust contained about 5 per cent iron.

Continuing the analogy, Mr. Hewett said, the pyramids of the different metal-bearing materials might be imagined to have different slopes. That of iron would be very flat, that of manganese less so, and that of copper or lead still less flat.

Obviously, from the standpoint of human usefulness, said the speaker, we tended to use the richest first and here and there, in favored areas, select parts of the next lower zone or zones. One could say that the whole record of progress in metallurgy arose out of attempts to use progressively lower-grade materials. With the advance in metallurgy, with therefore decreasing costs, successively lower grades might be considered as ore susceptible of profitable treatment.

Tariff Stimulated Ferro Output

J. W. Furness, of the U. S. Geological Survey, gave figures showing that the tariff on manganese had had an effect in stimulating production of ferromanganese but not of manganese ore.

Carl Zapffe, geologist for the Great Northern Railroad, was the author of a paper entitled "Reserves of Lake Superior Manganiferous Ores," which was presented in abstract at the end of the second session by L. P. Barrett.

Sir A. E. Kitson, director of the Gold Coast Geological Survey, now in London, had prepared a paper on the "Manganese Deposits of the Gold Coast," which was presented by title at the meeting. It had been printed and was in the hands of every person present.

Another paper, one of much interest to metallurgists, was that on "Iron-Manganese Alloys Low in Carbon," by Sir Robert Hadfield. In the absence of the author an abstract of its sixty-six typewritten pages was given by Dr. T. T. Read.

People You Should Know About

R. D. Leisk has returned to New York from Bolivia.

Charles A. Mitke is in Pennsylvania on professional business.

J. Allen Woodburn, mining engineer, with Mrs. Woodburn, left South Africa on March 15 for England.

Carl O. Lindberg sailed from New York on April 30 for Buenos Aires, to remain two or three months.

Carl Knutson has returned to Douglas, Ariz., after six months in various South American countries.

George W. Lambourne, president and general manager of the Park Utah Consolidated Mines Co., is in California.

Rogers, Mayer & Ball, mining engineers, announce the removal of their offices to 26 Beaver St., New York City.

Dr. J. Mackintosh Bell, managing director of the Vipond Consolidated, of Porcupine, has returned from a visit to Europe.

James W. Wade, assistant general manager of the Tintic Standard Mining Co., at Eureka, Utah, visited Washington, D. C., recently on business.

J. C. Jensen, a director of the Continental Divide Development Co., of Denver, has left Salt Lake City to take charge of operations at Aspen, Colo.

E. J. Raddatz, president and general manager of the Tintic Standard Mining Co., has returned to Salt Lake City from a month's vacation at La Jolla, Calif.

Van Court Warren, consulting geologist and valuation engineer, has established his office at 1025 Los Angeles Stock Exchange Building, Los Angeles, Calif.

Philip Lawrence Foster, not "Philip Lawrence," as announced, was recently appointed a director of the board of the Exploration Company Limited, of London.

W. R. Knox has been appointed to take charge of operations at Atlas, Churchill, and Algonquin properties in the West Shining Tree area of northern Ontario.

H. W. Hardinge, president of the Hardinge Company, sailed from New York April 16 for Europe. He will be absent some six or eight weeks on foreign business.

Hamilton M. Brush, vice-president and sales manager of the American Smelting & Refining Co., sailed for Italy on April 15. He is expected to return in June.

Lucien Eaton, manager of the mining department of the Cleveland-Cliffs Iron Co., visited the Utah Copper mine at Bingham, Utah, recently to study steam-shovel methods.

Louis Hirshler, president of the Hirshler Metals Co., and consulting engineer for the S. A. de la Vieille Montagne, Chénée, Belgium, sailed for Europe with Mrs. Hirshler on April 30.

Fred Marston sailed from New York on April 20 for London and Greece. He has formed a connection with the Compagne Française des Mines du Laurium, Laurium, Ergasteria, Greece.

William Allen Smith, who is installing a refining plant for the National Lead Co. at its smelter in Buenos Aires and who has been in the United States for a brief visit, sailed again for South America on April 21. Mr. Smith expects to be in Buenos Aires until the middle of August, when he will go to England for the month of September, returning to New York in the fall. Mr.

William Allen Smith

Smith was formerly manager of the smelting department of the St. Joseph Lead Co. and has done extensive metallurgical work for the Metallurgical and Chemical Corporation (the Harris process) at Matawan, N. J., for the Balbach Smelting & Refining Co. at Newark, N. J., and at other plants.

N. A. Dunyon, of Salt Lake City, consulting engineer and manager of the Park King and the Park Standard mines, spent the first week of April at the Park City, Utah, properties.

Prof. Alfred H. White, head of the research department of the University of Michigan, addressed the senior class of the Michigan College of Mining and Technology at the annual class day exercises at Houghton on April 21.

Alberto Terrones Benitez, of Mexico City, has been officially notified by the Secretary of Industry, Commerce and Labor of the Mexican Government of his appointment as a mining expert under the regulations provided in the Law of Mineral Industries.

Frank Harris McLearn, Dr. Eugene Poitevin, and **Thomas Leslie Tanton,** all of the Geological Survey of Canada, and **Bruce Rose,** of Queen's University, Kingston, Ontario, have been nominated for election to the Geological Section of the Royal Society of Canada.

Ernest Clayton Andrews, government geologist of New South Wales, will deliver seven Silliman lectures at Yale University, on "Some Problems in General Geology," in Sterling Chemical Laboratory at 3:15 o'clock in the afternoon on May 2, 4, 6, 9, 11, 13 and 16.

W. A. RuKeyser, consulting mining engineer, with offices at 342 Madison Ave., New York City, has recently returned from a two months' trip abroad, where he was engaged primarily in professional business in London. He is leaving immediately for Ontario, where he will be engaged for some time in examining properties in company with a group of Montreal capitalists.

Obituary

LeRoy Clark, mining engineer and former president of the Safety Cable Co., died at Falmouth, Mass., on April 18. He was fifty-five years old.

Mrs. Alice Ring Van Hise, widow of Dr. Charles R. Van Hise, geologist, and president of the University of Wisconsin from 1903 to 1918, died in Madison, Wis., on April 10.

Sir Frederick Moor, last Prime Minister of Natal, died on March 18 at Greystones, near Estcourt, in the Natal. He was born in 1853, near Greytown, and went to Kimberley and began as a digger there in 1872. He married Miss Moody, a granddaughter of the first Colonial Secretary of Natal. He is survived by Lady Moor, three sons and three daughters.

Douglas Lorne McGibbon, a prominent financier and promotor of Montreal, died on April 20 of heart disease at the age of fifty-seven years. He was closely associated with a number of industrial and commerical enterprises, and had been president of the La Rose Consolidated Mines Co. and a director of the Nipissing Mines Co. Mr. McGibbon took a keen interest in philanthropic and social welfare work. He leaves a widow.

James Carroll, one of the best-known mine managers of Charters Towers, once the premier gold field of Queensland, Australia, died at that place recently at the age of seventy years. Mr. Carroll arrived at Charters Towers when only eighteen years old. In mining activities his principal association was with the Brilliant & St. George United Co., which owned one of the richest gold mines ever worked on the field, and of which he was manager from its inception till the affairs of the company were liquidated some years ago. During its existence this mine produced 370,000 tons of ore, which yielded gold to the value of £1,750,000, and paid dividends amounting to £740,000.

W. C. Botsford, a well-known geologist of Inspiration, Ariz., met an accidental death on April 10. He was found lying near the front door of his home with his neck broken. It is supposed that he fainted and fell against the door in such a way as to cause the fatal injury. Mr. Botsford was in his fiftieth year. He was a graduate of the Michigan School of Mines in the class of 1900, and was a member of the A.I.M.E. He was at one time manager of the Guanajuato Mining Co., in Mexico, and was driven out during the revolution against Diaz. He later took up geological work and was sent to Chile by the Chile Copper Co. On his return to the United States he joined the Anaconda geological staff. He came to Miami in 1922, and since then had been with the Inspiration Copper Co. He is survived by his widow.

A. R. Wilfley a Mechanical Genius

An Intimate Friend Recalls Interesting Facts of His Character and Life

By Victor G. Hills

Arthur Redman Wilfley was generally known to the world as the inventor of the ore-concentrating table which bears his name; but it is not so generally known that he was possessed of remarkable native mechanical genius and that the production of this invention was not, as one of our mining editors referred to it, a mere outgrowth of necessity for the economic concentration of certain mixed sulphide ores. The remark was doubtless true in a limited sense; but if that editor had known something of the personality of the inventor he would have chosen some other case to illustrate his point.

Edison is quoted as saying that in the receipt for genius 75 per cent is good hard work; and Carlyle has put it that "Genius consists of an infinite capacity for taking pains." Both of these definitions fit the genius of A. R. Wilfley; but there was the animating spark to start with. He was a born inventor of the most pronounced type. His method of perfecting a device was the same as that ascribed to Edison.

Learning Surveying and Assaying

In the year 1882 Wilfley came to my office at Kokomo, Colo., to assist in mineral surveying work. The rapidity with which he mastered every detail of the work was such that it was difficult to realize that he had only a common country-school education. Without ever before having looked in a book on geometry or trigonometry he proceeded to go through those books as though reading a fascinating romance. He never hesitated or even asked a question until he encountered some algebraic formulas. As he had never studied algebra he had to call for some explanation. To learn to use a transit with skill, accuracy, and efficiency required only a single day.

In 1882, when S. F. Emmons was doing the Ten Mile folio of the U. S. Geological Survey, he came to my office to have some extra surveying done to complete the topographical map. Wilfley was assigned to this work, which consisted of stadia surveying. He had never used a stadia rod with the transit before the morning when I went out with him to start the work. This work lasted about two weeks and involved running long closed circuits. He and the government assistant geologist worked together in putting the work on the map, and not a single circuit needed material correction.

From J. C. Staats, assayer at the old Kokomo smelter, which was then in operation, Wilfley learned assaying.

When I left Kokomo for Pueblo, Colo., Wilfley became a partner at Kokomo for one year, but as the mine surveying business was then rapidly declining he began leasing in the closed Elk Mountain mines. He would spend his days crawling through abandoned stopes and contact drifts gathering samples and then spend most of the night assaying them. He would not take time to cook himself proper food. He was possessed of a strong physical constitution, inherited from both father and mother, but his continual robbing himself of sleep and proper nourishment began to break his health in early manhood.

Several Elk Mountain mines were readily leased and purchased because they were considered practically exhausted. There was no more oxidized or other smelting ores. The great bodies of mixed sulphides would not pay to ship without concentration. Yet by Wilfley's skillful sampling and his persistence he found enough overlooked ore to pay for the several old mines and acquire adjoining ground into which the shoots extended. During this period he began the concentration of these ores with jigs and old-style tables.

About the year 1891, A. R. Wilfley, D. D. Byron, and Thomas F. Walsh formed a partnership to erect an Austin Process smelter at Kokomo. Wilfley and Byron between them had become owners of a large portion of the area covering the contact deposits of Elk Mountain, and Walsh furnished some smelting experience and probably the greater portion of the cash. The smelter was just starting with its first run when the silver crash came, and all three of them were left flat broke. Walsh later recovered and made his fortune from the famous Camp Bird mine and Wilfley by the invention of his table, but Byron died possessed of only his interest in the mining ground, which was of modest value.

The Concentrating Table

It was during Wilfley's operations of handling the Elk Mountain mixed sulphide ores, and while continuing to make some small shipments of smelting ore, and to concentrate by the old methods, that he began his intense and persistent experimenting which resulted in the invention of the table which bears his name. That this invention revolutionized the mining industry of the whole world has been fully recognized. In common with every invention of great commercial value it was quickly followed by a flood of imitations, infringements, improvements and other patents designed to avoid the patent or secure an interest in it. I recall that there were two hundred and thirty-odd patents of this class and there were a number of hard-fought lawsuits. Wilfley was the winner in all of the more important of these suits. Professor Richards, of ore dressing fame, as an expert witness in one of these cases, characterized the Wilfley as a positive basic invention, and this view was generally sustained by the courts as well as recognized by the mining world. Wilfley's concentrating table made his name and fortune. He was justly gratified when Webster's International Dictionary took the name and thus perpetuated it in the English language and internationally.

However, the table was not Wilfley's only contribution to mining, milling, and practical mechanics. It would be quite impossible to enumerate his many devices for improving and expenditing work about a mill or machine shop. Many of these were unimportant commercially or considered not worth patenting. He never attempted to patent small things—such things as have often proven the best money makers for the inventor. And some really important inventions were regarded as not patentable. His wet gravity slime table was probably the best ever devised, but it was given to a mining-supply company to manufacture and the company attempted to sell it on the name without following up and correcting minor details of construction; and soon flotation developed, with the result of rendering all gravity slime concentration obsolete.

Wilfley's roasting furnace I believe insures the most delicate and perfectly controllable means of ore roasting ever devised, and is without a peer for the purpose of a laboratory or an ore-testing plant; but it is not economical of fuel, and, like the slime table, was sold to a mining-supply company, which depended on its name and made no effort to perfect it for commercial use.

His Last Invention

Wilfley's latest production, the centrifugal pump operating with a centrifugal seal and without any gland water, and thus without the necessity of diluting heavy sand pulps, is positively unique in its essential features and, it seems to me, involved deeper thought and ingenuity than the famous table. It has thoroughly proven itself most practical and economical.

Wilfley's Personal Character

Wilfley's bashfulness and retiring disposition were most pronounced and not of the sort which disappeared after childhood; yet this was scarcely discovered by those who met him in later business life. In this extreme retiring disposition he differed greatly from father, mother, brothers, and sisters. He could never be induced to procure a dress suit and would avoid any meeting or company where he might be asked a question or attract attention. He was an honorary fellow of the Colorado Scientific Society. He had been a member some thirty years because he wanted to read the *Proceedings;* but he never attended a meeting. He never joined a secret society, never drank alcoholic liquors, did not smoke, dance, or play cards. This was not from any moral propensity, but simply because he looked upon all such things as a pure waste of time. Although he became wealthy far beyond independence, yet he was far from being a money maker. In business deals the other fellow was likely to get the better of the bargain.

Wilfley survived four years after being told by Dr. Mayo that he had probably less than a year to live. During all of this time he worked continually, as far as possible, to perfect the porcelain acid pumping form of his latest patents and barely lived to see it working and declared a success under commercial working conditions.

Market and Financial News

Impressive Record Shown in Utah Copper Report of Operations for 1926

Operating Costs 90c. per Ton—Net Profit $13,809,310

Per-ton operating costs of the Utah Copper Co. in 1926 were the lowest on record with the single exception of 1915; and the cost per pound of copper was bettered in only 1915 except for years when the figures are not comparable. From the treatment of 13,880,100 tons of ore containing on the average only 20.2 lb. of copper, a net profit of $13,809,310 was realized after providing for all costs except depletion. Refined production was 234,173,000 lb. The per-ton operating cost was 90.01c. and the per-pound cost of producing copper was 7.94c., compared with 8.43c. for the preceding year. The accompanying table summarizes the results of the year's operations.

The mining cost per ton of ore milled, including a proper apportionment of fixed and general charges (not including federal taxes and depreciation) was 31.39c., of which 12½c. represents proportional prepaid stripping charges. The actual direct mining cost of all ores was 18.89c. per ton, of which 15.21c. represents all mine charges and the balance, or 3.68c., is fixed and general charges.

Financial Statement—Utah Copper Co.—1926

Operating revenue		
Copper produced—234,173,625 lb.@13.894c		$32,537,384.08
Gold produced—86,028,040 oz.@$20		1,720,560.80
Silver produced—760,909.69 oz.@61.27c		466,176.54
		$34,724,121.42
Operating expenses		
Mining, including stripping charge	$4,399,675.60	
Ore delivery—mine to mill	1,414,974.76	
Milling	6,722,085.63	
Treatment, freight, and refining	7,734,031.56	
Selling expense	292,717.03	20,563,484.58
Profit from operations		$14,160,636.84
Miscellaneous income—net		2,425,749.33
Total income		$16,586,386.17
Charges against income		
Depreciation	$1,229,357.82	
Plant and equipment retirements	228,794.67	
Federal income tax and other charges	1,318,922.81	2,777,075.30
Net income to surplus account		$13,809,310.87

According to the report of L. S. Cates, general manager, churn-drill development in six holes was continued during the year and a total of 4,499 ft. was drilled. This work is for the purpose of defining the limits of the orebody in general and developing the commercial grade ores of the Starless group. Development will continue for some years to come and from time to time, as the work progresses, additions will be made to the reported ore reserves. During the last year 64,000,000 tons was developed, and the reserves as of Dec. 31, 1926, as they will be mined, amount to approximately 564,000,000 tons, averaging 1.10 per cent copper. The total ore mined to date is 145,774,651 tons. It is apparent, therefore, from information available at this time, that the total ore mined and to be mined will exceed 710,000,000 tons.

In order to keep stripping far enough advanced to permit the proper conduct of mining operations, there was removed 8,633,769 cu.yd. of capping, bringing the total to the end of the year up to 79,825,135 cu.yd.

During the year six steam shovels were converted to electrically operated shovels, so that at the end of the year all of the twenty-three shovels in use at the property were electrically operated. The necessary power-transmission lines to supply electric current to the shovels were constructed. One 60-ton oil-electric locomotive was purchased. One of the stripping lines was equipped with trolley wire and early during the present year an electric locomotive will be delivered and a test will be run to determine whether the oil-electric or trolly-electric locomotive, or either, will be the better motive power to supplant the present steam locomotives.

The tonnage of ore treated at the Magna and Arthur plants was 7,454,200 and 6,425,900, respectively, or a total of 13,880,100, equivalent to a daily average of 38,028 tons. The average copper content of the ore was 1.01 per cent, or 20.2 lb. per ton, as compared with 1.02 per cent and 20.4 lb. for the year 1925. Average recovery in the form of concentrates was 87.01 per cent, corresponding to 17.58 lb. of copper per ton, as compared with 86.96 per cent and 17.78 lb. for the year 1925.

The average milling cost per ton of ore was 48c., a decrease of 6c. as compared with 1925. Improvements which have been in progress at the mills for several years, looking to an economic capacity of 50,000 tons per day for both plants, were completed. The principal items of these were increased crushing and grinding capacity and improved classifying and flotation apparatus.

The following operating officials are deserving of credit for the success of the year's work: L. S. Cates, vice-president and general manager; D. D. Moffat, assistant general manager; J. D. Shilling, superintendent of mines; E. J. Franklin, consulting mechanical engineer; R. G. Lucas, industrial relations department; C. M. Brown, superintendent welfare department; H. C. Goodrich, chief engineer; E. E. Barker, engineer of mines; Roy Hatch, superintendent Arthur plant; E. W. Engelmann, superintendent Magna plant; and T. A. Janney, chief metallurgical engineer.

Statistical Notes

Annual reports of mining companies are being issued in such numbers that it is impossible for the *E. & M. J.* to give adequate reviews of them promptly on publication. The following notes give a few salient features of the financial results of operations in 1926, but in subsequent issues more detailed abstracts of the reports of the larger companies will be published.

Howe Sound Co. reports an operating income of $4,284,150 on a gross income of $14,009,077. Taxes and depreciation reduced this to $3,107,274; and depletion to $2,697,748.

Patiño Mines & Enterprizes realized $6,345,741 from its mining operations and $201,613 from the railroad. After bond interest and taxes the profit was $5,900,960; and after deducting reserves for depreciation and depletion, balance to surplus was $4,286,085. The corresponding figure for 1925 was $4,815,533.

Premier Gold Mining Co. shows the following summary of financial results in 1926:

Value of ore sold	$3,782,032
Operating expense	1,582,401
Total earnings	2,211,490
Taxes, depreciation and depletion	1,414,362
Available for dividends	797,127

National Lead Co. reports net earning for 1926 as $9,004,566. Surplus at the end of the year was $32,716,745, compared with $27,070,343 at the end of the preceding year. Total assets increased during the year from $95,931,553 to $101,808,385.

Inspiration Consolidated Copper Co. realized gross income of $10,721,993 during 1926. Expense, including taxes, totaled $9,575,552, and after making an adjustment for an increase in the inventory value of copper unsold, and charging $348,871 to depreciation, the net income is reported as $1,310,896. This compares with $1,816,801 for 1925.

Wright-Hargreaves Mines, Ltd., during 1926 sold bullion to the value of $2,150,843. Net to surplus after all charges was $1,392,746. Production of bullion during the previous year was $1,913,401.

Nevada Consolidated Copper Co., in which are now included the Ray and Chino units, reports consolidated income for 1926 of $33,003,684 and net profit of $6,832,395. This is equal to $1.86 per share of the outstanding stock.

United States Smelting, Refining & Mining Co. in its consolidated profit-and-loss account for 1926 shows profits, after reserves for depletion, depreciation, and taxes, amounting to $4,039,164.

Miami Copper Co. reports for the year 1926 net income of $1,138,079, compared with $1,121,158 in 1925. These figures are before charges for depletion. Gross income was lower than in 1925, but operating costs and taxes decreased largely.

Granby Consolidated Copper Co. in 1926 realized gross revenue of $8,718,232 with a gross operating profit of $2,380,711, or $2,001,464 after taxes and administration. This last figure compares with $1,273,395 in 1925. After deducting bond interest amounting to $251,349 and book charges for depreciation and depletion, the report shows a net deficit of $527,773.

Mohawk Mining Co. reports for 1926 a net profit of $699,600 after all charges, including depletion. Income from the sale of 16,738,000 lb. of copper was $2,386,159.

Tonopah Belmont Development Co. realized net earnings from operations in Nevada of $61,492. After meeting administration and miscellaneous expense the net was $35,613.

Tennessee Copper & Chemical Co. reports net income of $1,089,617 after depreciation, taxes, and interest, comparing with $820,247 for 1925.

New Cornelia Copper Co. shows net income before depletion of $3,714,547 for 1926; this compares with $1,126,153 in 1925, calculated after a deduction of $1,603,355 for depletion. Gross income increased from $10,283,643 to $11,722,553.

Calumet & Arizona Mining Co. reports an operating income of $4,095,929 for 1926, compared to $2,720,316 for 1925.

Kennecott Copper Corporation shows the following financial results for 1926 together with a comparison for 1925:

	1926	1925
Operating revenues	$72,096,237	$67,863,114
Operating expenses	39,254,160	37,891,529
Net revenue	$32,842,077	$29,971,585
Other income	2,164,053	2,315,025
Total income	$35,006,130	$32,286,610
Interest	101,250	495,556
Depreciation	4,000,721	3,991,608
Taxes	4,248,845	3,369,159
Balance	$26,655,314	$24,430,287
Minority interest in subsidiaries	586,031	540,243
(a) Net income	$26,069,283	$23,890,044
Dividends	17,898,691	6,904,082
(a) Surplus	$8,170,592	$16,985,962

(a) Before depletion.

Consolidated Mining & Smelting Co. of Canada in the first quarter of 1927 produced 34,153 tons of lead, against 30,527 in first quarter of 1926; 16,232 tons of zinc, against 14,439; and 2,343 tons of copper, against 2,194. Silver output was 1,720,068 oz., compared with 1,790,758 oz. in the first quarter of last year, and gold 7,446 oz., against 12,475.

Lower Metal Prices Affect April Mining Dividends

Recent declines in metal prices have affected the dividends paid by several mining companies, and the total of April dividends is less than that of January, though greater than the amount paid for the corresponding quarter, six months ago, and also well above that of April, 1926. Yields on some stocks are correspondingly less, though the average is 11 per cent, as shown in the table. Chief Consolidated apparently passed its regular dividend due this month, as did Cleveland Cliffs Iron. Inspiration cut its previous 50c. dividend in half; Ahumada paid only 12½c. instead of 15c., and its subsidiary, Erupcion, paid 7½c. instead of 10c. Plutus, a Utah silver-lead producer, apparently passed its dividend. Kerr Lake cut its semi-annual dividend from 12½ to 6c.

The news is not all bad, however. Consolidated Lead & Zinc doubled its previous dividend of 12½c., and Park Utah found it possible to pay 20c. instead of 15c. Vipond, operating in the Porcupine district, paid its first dividend.

Chile Copper's dividend would ordinarily have been paid in March, and swells the April total unduly. On the other hand, the quarterly dividend of Dome was due this month, but will not be paid until May; incidentally this has been reduced from 50 to 25c., as was rather expected.

Mining Dividends and Yields, for April, 1927

Companies in the United States	Situation	Per Share	Total	Per Cent Annual Yield
Aluminum Co. of America	Various	$1.50 Q	$1,104,570	5.8
Bingham Mines, s,l	Utah	1.00 Q	50,000	8.6
Bunker Hill & Sullivan, l,s	Idaho	0.75 M	245,250	12.0
Caledonia Mining, s,l	Idaho	0.10 L	260,500	...
Consolidated Lead & Zinc	Kansas	0.25 Q	50,000	6.7
Cresson Consolidated Gold	Colo.	0.10 Q	122,000	20.0
Eagle-Picher Lead pfd., l,z	Okla., Mo.	1.50 Q	12,769	5.2
Gladstone Mountain, l	Wash	0.005 M	6,609	23.7
Homestake Mining, g	S. D.	0.50 M	376,740	j 11.4
Inland Steel pfd	Minn.	1.75 Q	175,000	6.2
Inspiration Consolidated Copper	Ariz.	0.25 Q	295,492	5.3
Kennecott Copper	Alaska	1.25 Q	5,620,754	7.8
Magma Copper, c,s	Ariz.	0.75 Q	306,116	8.6
Newmont Mining, h	Various	0.60 Q	271,656	3.2
Nichols Copper pfd	N. Y.	1.75 Q	40,173	...
Park Utah Consolidated, s,l,z	Utah	0.20 Q	418,700	11.4
Phelps Dodge, c	Ariz., N. M.	1.50 Q	750,000	5.0
Portland Gold	Colo.	0.02 Q	60,000	17.0
Republic Iron & Steel pfd	Various	1.75 Q	437,500	6.7
Silver King Coalition, s,l	Utah	0.25 Q	304,025	12.7
Sloss-Sheffield Steel & Iron pfd	Ala.	1.75 Q	117,250	6.4
Tonopah Mining, s,g	Neb.	0.075 SA	75,000	6.3
U. S. Smelting, Refining & Mining, s,l	Various	0.875 Q	307,226	9.3
U. S. Smelting, Refining & Mining pfd	Various	0.875 Q	425,556	7.2
Companies in other countries				
Ahumada Lead, l,s	Chihuahua	0.125 Q	149,002	12.9
Asbestos Corporation pfd	Quebec	1.75 Q	130,482	8.0
Chile Copper	Chile	0.625	2,744,581	6.7
Erupcion, l,s	Chihuahua	0.075 Q	93,750	54.5
Hollinger Consolidated Gold	Ont.	0.10 4 wks.	492,000	6.3
Howe Sound, s,c,l	B. C., Mex.	1.00 Q	496,038	10.5
Kerr Lake, s,g	Ont.	0.06 SA	36,000	16.0
Lucky Tiger-Combination, g,s	Sonora	0.05 M	35,767	8.7
New York & Honduras Rosario, g,s	Honduras	0.50 Q	100,000	...
Nipissing, s	Ont.	0.15 Q	180,000	8.3
Premier Gold, s,g	B. C.	0.08 Q	400,000	15.0
Vipond Consolidated, g	Ont.	0.03 I	75,000	...
Total and average			$16,765,500	11.0

s, silver; l, lead; z, zinc; g, gold; c, copper; h, holding; Q, quarterly; M, monthly; L, liquidation, SA; semi-annually; I, initial; j, based on dividends for the last twelve months.

Federal Mining & Smelting Co., operating in both the Coeur d'Alene district in Idaho and the Tri-State district in Oklahoma, for the quarter ended Jan. 31, reports net earnings of $916,133 before depreciation, depletion, taxes, and charges for construction and equipment, compared with $1,064,342 in the preceding quarter and $1,408,950 in the quarter ended Jan. 31, 1926. The company shipped 48,708 tons of concentrates, compared with 47,600 tons in quarter ended Jan. 31, 1926.

Eagle-Picher Lead Co. shows the following consolidated income account for the year ended Dec. 31, 1926:

Gross income		$4,833,052
Selling expense	$1,343,422	
General and administrative expense	450,018	
Depreciation and depletion	974,793	
Federal income tax	240,000	
		3,008,233
Net profit		$1,824,818

Engels Copper Mining Co., operating in Plumas County, in California, during 1926 produced 13,344,000 lb. of copper and 182,940 oz. of silver, having a gross value of $1,979,984. The average copper content of the ore was 1.785 per cent, compared with 1.979 per cent in 1925. Profit from operations before deductions for depletion and sundry reserves amounted to $259,283. Miscellaneous income brought gross profit to $344,484. Depreciation, development, and other write-offs, amounting to $156,588, left a net balance of $187,896 to surplus. Ore reserves at the end of the year are estimated at 906,228 tons, having an approximate copper content of 40 lb. to the ton. The total cost of producing copper before crediting gold and silver was 13.0292c. This figure includes depreciation and "development amortization." Gold and silver credits totaled 3.9603c. per pound of copper; and the average selling price was 13.80c. per pound.

The Market Report

Metal Prices Sag in Dull Market

Copper Back to 13c.; Buying Movement Not Sustained

New York, April 27, 1927—Food for optimists is distinctly lacking in the non-ferrous metal markets this week, having regard both to the volume of sales and the prices received. Copper, lead, zinc, tin, silver, and platinum are all selling at lower prices than last week, both here and in London, but the lower prices are not attracting buyers. Metal consumption is generally good but production is more than adequate.

Little Interest in Copper

Copper was held at 13¼c. Valley delivery last Thursday, but as early as Friday at least one seller was willing to book orders at 13c. and did a fair business during the next few days at that level, as most others were quoting 13⅛c. Producers' ranks have gradually weakened to the 13c. level, however, and that price is general today. Business has reverted to the quietude that characterized the market in March, and no great activity is expected until the April statistics are issued around the tenth of May. The indications are that these will be distinctly favorable and will confirm the March trend. Companies manufacturing brass and sheet copper report a continuance of excellent business, fully up to the 1926 rate, though wire business is slack. May copper seems to be pretty well contracted for; producers are well sold on this position, and consumers do not seem anxious for prompt shipment. One good block of copper was sold for delivery as far ahead as July and August.

The export market has been lifeless until today, when the export association reduced its c.i.f. price from 13.50 to 13.35c., resulting in a little more buying. Most of the inquiry abroad is for prompt shipment.

Lead Prices Decline

A moderate volume of lead business was transacted in the St. Louis market during the week ending today, though at definitely lower price levels, 6.55c. being the prevailing figure since Monday. The New York market has been exceedingly dull, and except for contract sales very little lead has brought the Smelting company's official New York price of 7c. A price of 6.55c. in St. Louis is equivalent to 6.90c. in New York, and this is very close to parity with London for foreign-ore lead. The London price has been maintained fairly well in spite of the diversion recently of most of the Mexican ore lead to the foreign market. Antimonial lead has been active at a premium of ¼c. or more above desilverized. Corroding grades command the usual premium of $2 to $3.

Zinc Nears 6c.

Zinc sold at varying prices between 6.25 and 6.35c., St. Louis, last Thursday, with the largest volume at the lower limit. Since then the market has weakened to as low as 6.10c. for all deliveries, at which level a fair business was done on Monday and Tuesday. Sales have been at about the same rate as during the last five weeks, and well below the average rate for the year to date. Further curtailment in production is likely as ore approaches $40 a ton, $41 being last Saturday's figure; this is the logical remedy for the situation. The market is now at or near export parity, so that favorably situated smelters may sell Prime Western in the export market. High-grade is now offered at 8c., delivered in the East.

Tin Quiet

The speculative situation in London caused a decline in domestic tin to a low of 66½c. for prompt Straits on Monday. Since then both the foreign and domestic markets have recovered some of the lost ground. The factor in the market is the curtailment in the operations by tin-plate manufacturers said to be brought about by over-stocking in the canning industries. Domestic consumers were attracted to some extent by lower prices, but most of the business has been speculative. Though spot sup-

Daily Prices of Metals

April	Copper	Tin		Lead		Zinc
	Electrolytic, N. Y	99 Per Cent	Straits	N. Y.	St. L	St. L
21	12.90	65 00	67.00	7 00	6 60@6 80	6 275
22	12 80	64 625	66 625	6.925@7 00	6.60@6.65	6 20@6 25
23	12.80	64 50	66 50	6.925@7 00	6 60	6 20@6 25
25	12.775	64 00	66 50	6.925@7.00	6 55@6.60	6 10@6.175
26	12 775	64 25	66 75	6.90 @7.00	6.55	6 10@6 125
27	12 75@12.775	64.75	67 25	6.90 @7.00	6 55	6 10@6.125
	12 802	64 521	66 771	6.965	6 600	6 181

Average prices for calendar week ending April 23, 1927, are: Copper, 12.844c.; 99 per cent tin, 65.500c.; Straits, 67.542c.; N. Y. lead, 7.038c.; St. L. lead, 6.717c.; zinc, 6.292c.; and silver, 56.375c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis: i.e., delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted, and prices at so-called Middle West destinations, 0.325c. above.

Quotations for copper are for ordinary forms of wire bars, ingot bars, and cakes. For ingots an extra 0.05c. per pound is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

April	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
21	55 5/16	55 15/16	61¾	298¼	293¾	26 5/16	26¾	29½	29¾
22	55⅜	55⅞	61¾	295	291⅜	26 1/16	26½	29⅜	29⅝
25	54¾	55⅜	61¾	294	290¾	25 9/16	26	29⅛	29 3/16
26	54 13/16	55⅜	61½	294¼	290¼	25 7/16	26⅜	29⅛	29 5/16
27	54¾	55 5/16	61¼	296	291⅞	25 13/16	26¼	29¼	29½

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Apr.	Sterling Exchange "Checks"	Silver		Gold London	Apr.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
21	4 85¼	56½	26 3/16	84s11d	25	4 85¼	56	25⅞	84s11 1/2d
22	4 85⅛	56½	26¼	84s11½d	26	4 85¼	56	26 1/16	84s10¾d
23	4 85⅛	56¼	26	.....	27	4 85¼	55⅞	25⅞	84s11½d
					Avg.		56.188		

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-half cent premium.

plies of both Straits and 99 per cent are small, plenty of metal is afloat, and no difficulty should be experienced in meeting requirements.

Silver Market Easier—Close, April 27, 55⅞c.

The silver market has experienced a weak tendency during the past week, being quoted at 56⅛c. on April 21 and closing today at 55⅞c. Advices from London state that the Indian bazaars have been selling. China has been inactive, and the market closes with an easier tendency.

Mexican Dollars (Old Mexican pesos): April 21st and 22d, 42⅝c.; 23d, 42¾c.; 25th and 26th, 42⅜c.; 27th, 42⅜c.

Foreign Exchange

Closing cable quotations on Tuesdav, April 26, were as follows: francs, 3.91¾c.; lire, 5.33c.; and marks, 23.70½c. Canadian dollars ⅛ per cent premium.

Other Metals

Quotations cover large wholesale lots unless otherwise specified. London prices are according to latest mail advices.

Aluminum—Per lb., 98 or 99 per cent grade, price of leading interest, 26c.; outside market, 25.30@25.80c. London, 98 per cent, £105@£107 per long ton for domestic consumption.

Antimony—Per lb., duty paid, New York: Chinese brands, spot business at 14½@14⅝c.; July arrival about ⅛c. higher; Cookson's "C" grade, spot, 18c. Market dull. Needle antimony nominally 8c. for lump and 10c. for powdered. White oxide, 16½c.

Bismuth—Per lb., New York, in ton lots, $2.20@$2.25. London, 8s.

Cadmium—Per lb., New York, 60c. London, Australian metal selling freely at 1s. 10d.

Iridium—Per oz., $112@$117 for 98 @99 per cent sponge and powder.

Nickel — Per lb., ingot, 35c.; shot, 36c.; electrolytic, 39c. (99.75 per cent grade). London, £170@£175 per long ton, according to quantity.

Palladium—Per oz., $58@$61. Small lots bring up to $65. Pure metal as a constituent of crude platinum, $50@ $53 per oz. London, £11@£12, nominal.

Platinum — Official price quoted by the leading interest on miscellaneous orders for refined metal, $98. Price cut from $102 on April 20. Open market cash sales of large lots, in New York, $85@$90. Pure metal as a constituent of crude platinum, $83@$85. Market for refined and crude unsettled owing to Russian offerings.

London, £20¾@£21 per oz. for refined and £18½@£19½ for crude. Dull.

Quicksilver—Per 75-lb. flask, $125. Steady. Demand good. San Francisco wires $123.33. London, £22 10s.@£23.

The prices of Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Monel Metal, Osmium, Radium, Rhodium, Ruthenium, Selenium, Tellurium, Thallium, Tungsten, and Zirconium are unchanged from the issue of April 9.

Metallic Ores

Manganese Ore—Per long ton unit of Mn, c.i.f. North Atlantic ports, minimum 47 per cent Mn, 37c. Caucasian (washed), 53@55 per cent, 40c. Business dull. Chemical grades unchanged from quotations in the April 9 issue.

Tungsten Ore — Per unit of WO_3, N. Y.: Wolframite, $10.75@$11; Western scheelite, $11@$11.25. Dull; prices largely nominal.

Chrome, Iron, Molybdenum, Tantalum, Titanium, Uranium, and Vanadium Ores are unchanged from quotations in the April 9 issue. Prices for Lake Superior iron ores have been reaffirmed for the current season.

Lower Prices for Zinc Blende and Lead Ore

Joplin, Mo., April 23, 1927

Blende

High	$44.80
Premium Blende, basis 60 per cent zinc	$42.00@ 43.00
Prime Western, basis 60 per cent zinc	41.00
Fines and slimes, basis 60 per cent zinc	40.00@ 37.00
Average settling price, all zinc	41.34

Galena

High	$94.90
Basis 80 per cent lead	90.00
Average settling price, all lead	92.15

Shipment for the week: Blende, 15,158; lead, 2,989 tons. Value, all ores the week, $901,990.

Buyers loaded out this week all of last week's purchase and an additional tonnage of 780 tons, held back from shipping on account of rains and floods. Heavy water from the same cause is lowering production, this week to approximately 14,500 tons. Another cause for the lower production is that a number of mills are engaged in retreating tailing and saving the ground reserves for a higher market price of zinc.

Shipments of lead continue to drain the bin reserves of this mineral, the shipment each week exceeding the production.

Platteville, Wis., April 23, 1927

Zinc Blende	Per Ton
Blende, basis 60 per cent zinc	$44.75
Lead Ore	
Lead, basis 80 per cent lead	$95.00

Shipments for the week: Blende, 1,158 tons; lead, 120 tons. Shipments for the year: Blende, 20,981; lead, 640 tons. Shipments for the week to separating plants, 2,308 tons blende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fullers Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, Tripoli, and Zircon are unchanged from prices in the April 9 issue.

Mineral Products

Arsenious Oxide (White Arsenic)—3¾c. per lb. A few carloads sold.

Sodium Nitrate—Crude, per 100 lb., ex vessel, Atlantic ports, $2.10, second half 1927; quiet.

Calcium Molybdate, Copper Sulphate, Sodium Sulphate (Salt Cake), and Zinc Oxide are unchanged from prices in the April 9 issue.

Ferro-Alloys

Ferrochrome—Per lb. of contained chromium, 60@70 per cent chromium, 4@6 per cent carbon, 11½c.

Ferromanganese—Domestic and foreign, 78@82 per cent, $100 per long ton, furnace or duty paid, for delivery during first half of 1927. Spiegeleisen, 19@21 per cent, $37, f.o.b. furnace; 16@19 per cent, $35; nominal.

Ferrotungsten—$0.98@$1.03 per lb. of W contained, f.o.b. works. Market spotty.

Ferrocerium, Ferrophosphorus, Ferrosilicon, Ferrotitanium, Ferro-uranium and Ferrovanadium are unchanged from prices in the April 9 issue.

Metal Products

Rolled Copper—Sheets, 21¾c.; wire, 15c.@15½c. f.o.b. mill.

Lead Sheets—Full rolled, 10½c. per lb.; clipped, 10¾c.

Nickel Silver—28¾c. per lb. for 18 per cent nickel Grade A sheets.

Yellow (Muntz) Metal—Dimension sheets, 19½c. per lb.; rods, 16½c.

Zinc Sheets—9¾c. per lb., f.o.b. mill. Cut from 10½c. on April 25.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and Zirkite are unchanged from quotations in the April 9 issue.

Steel, Iron, and Coke Quiet and Dull

Pittsburgh, April 25, 1927

Buying of finished steel has decreased somewhat more rapidly in the last week or two than in the forepart of April, and is now at considerably below the rate in March, which was the highest for some time. The decrease is largely seasonal, but an added influence perhaps is liquidation of stocks of steel accumulated against possible coal-strike interference with production. The coal strike is now regarded as of little consequence, although there remain chances of its becoming serious in the next few months.

The consuming industries are all doing fairly well, except that oil- and gas-well drilling programs are light.

Finished-steel prices are a trifle easier in several lines, but there is no definitely quotable decline.

Pig Iron—The Valley market remains dull. One producer has advanced its asking price on foundry from $18.50 to $19. Bessemer is quoted at $19; basic, $19; foundry, $18.50@$19. The American Steel Foundries is inquiring for 2,500 tons of basic iron.

Connellsville Coke — Spot coke has weakened, demand being light and offerings fairly heavy. Production is curtailed. There has been no labor trouble, but the chances of strikes later are not entirely removed. Spot furnace is quoted at $3.15@$3.35; spot foundry, $4.25@$4.75.

Current Prices of Mining Supplies

Rise and Fall of the Market

ONE of the most important developments of the last month was the adoption (April 1, 1927) of new lists on bolts, nuts, etc., at mills throughout the country. A slackening of demand gave price declines a considerable lead over the advances. Quotations are above the March levels on blue-annealed sheets, c.-i. pipe, rope and linseed oil, while lower prices prevail in black and galv. sheets, hollow tile, mine timbers, wire nails, packing and litharge.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh, Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2.20@2.30	$3.60	$3.50	$3.75	$3.89
Black					
No. 24	2.70@2.80	4.45	3.95	4.70	4.20
Galvanized					
No. 24	3.65@3.70	5.25	4.80	5.25	4.95

STEEL RAILS—The following quotations are per ton f.o.b. Pittsburgh and Chicago for carload or larger lots:

	Pittsburgh—Current	Pittsburgh—One Year Ago	Birmingham	Chicago
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00
Standard openhearth rails	43.00	43.00	43.00	43.00

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh—Current	Pittsburgh—One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, $\frac{5}{16}$-in. and larger	$2.80–3.00	$2.80	$3.55	$3.65	$3.85	$3.00
Track bolts	3.90–4.50	3.90@4.15	4.55	4.60	5.35	3.90
Standard section angle bars, splice bars or fish plates	2.75	2.75	3.40	3.75	3.90	4.15

STRUCTURAL MATERIAL—Following are base prices in carload lots, f.o.b. mill, Pittsburgh and Birmingham together with quotations per 100 lb. in less than carload lots, from warehouses at places named:

	Pittsburgh, Mill	Birmingham Mill	New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$1.90	$2.05	$3.34	$4.15	$3.25	$3.10	$3.00
Channel, 3 to 15 in.	1.90	2.10	3.34	4.15	3.25	3.10	3.00
Angles, 3 to 6 in., $\frac{1}{4}$ in. thick	1.90	2.10	3.34	4.15	3.25	3.10	3.00
Tees, 3 in. and larger	1.90	2.10	3.34	4.15	3.35	3.10	3.00
Plates $\frac{1}{4}$-inch thick	1.80@1.90	2.00	3.34	4.15	3.25	3.10	3.00

WIRE ROPE—Discounts from list price, f.o.b. New York and east of Missouri River, on regular grades of bright and galvanized are as follows:

Cast steel round strand rope	20%
Galvanized steel rigging and guy rope	7½%
Round strand iron and iron tiller	5%
Plow steel round strand rope	35%
Special steel round strand rope	30%
Galvanized iron rigging and guy rope	+12½%

	New York	Cleveland	Chicago
Drill Rod (from list)	60%	55%	50%

WROUGHT IRON AND STEEL PIPE—The following percentage discounts are to jobbers for carload lots at Pittsburgh mill:

	Steel Inches	Steel Black	Steel Galv.	Iron Inches	Iron Black	Iron Galv.
BUTT WELD—	..1 to 3	62	50½	1 to 1½	30	13
LAP WELD—	..2½ to 6	59	47½	3 to 6	28	13

WROUGHT-STEEL PIPE—From warehouses at the places named the following discounts hold for steel pipe:

	Black—New York	Black—Chicago	Black—St. Louis
2½ to 6 in. lap welded	48%	51%	46%

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	New York—Current	New York—One Year Ago	Birmingham	Chicago	St. Louis	San Francisco
6 in. and over	$48.60	$51.60@53.60	$38.00 base	$46.20	$43.60	$56.00

NUTS—Hot pressed or cold punched, square or hexagonal, blank or tapped, full kegs or cases, discount 50-10% from new list April 1, 1927 at warehouses in New York and vicinity.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building and partition tile.

	New York—Current on Trucks‡	New York—One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco‡	Perth Amboy N. J., Factory
4x12x12	$0.1027	$0.1112	$0.076	$0.10	$0.068	$0.108	.....
6x12x12	.1541	.1667	.104	.....	.09	.156	$0.2388*
8x12x12	.1926	.2084	.142	.20	.126	.244	.2956†

* 10x12x12; † 12x12x12. ‡ Partition tile.

MACHINE BOLTS—Square heads and nuts, up to 1x30-in., full kegs or cases, discount 50% from new list April 1, 1927 at warehouses in New York and vicinity.

LUMBER—Prices of rough Douglas Fir No. 1 common, in carload lots to contractors at yards in San Francisco.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft
3x3 and 4	$26.00	$27.00	$28.00	$31.00
3x6 and 8	26.00	27.00	28.00	31.00
4x4-6 and 8	26.00	27.00	28.00	31.00

Wholesale prices to dealers of long-leaf, yellow pine. To contractors in New York City, delivered from lighters to job, $5@$10 additional.

	New York—20 Ft. and Under	New York—22-24 Ft.	Chicago—Up to 20 Ft., Pine	Chicago—Up to 32 Ft., Fir
3x4 to 8x8	$40.00@42.00	$41.00@43.00	$38.50	$40.50
3x10 to 10x10	42.00@49.00	48.00@50.00	45.00	40.50
3x12 to 12x12	54.00@56.00	55.00@57.00	56.00	40.50

Other Cities	8 x8-In. x 20 Ft. and Under—Pine	Fir*	Hemlock	Spruce	12 x 12-In. 20 Ft. and Under—Pine	Fir*
Boston	$48.25	$48.25†	$50.00	$52.00	$58.50	$58.25†
Cincinnati	37.00	73.00	73.00	85.00	48.00	77.00
Denver	.....	33.25	34.25	34.25	.....	33.25
Minneapolis	42.50	38.75	34.50	.....	45.00	38.75
Kansas City, Mo.	41.50	37.75	.....	.....	55.50	37.50
Philadelphia	54.00	35.00	38.00	45.00	65.00	35.00

*Douglas fir. † Prime.

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh, Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.55	$2.95	$3.45	$4.25	$2.85	$4.95
Cut	2.80	....	5.00	5.00	3.00	5.00

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots *without bags*. Cash discount not deducted.

	Current	One Month Ago	One Year Ago
NewYork, del. by truck	$2.35@2.50	$2.35@2.50	$2.50@2.60
Chicago, f.o.b.	2.05	2.05	2.10
Cleveland, f.o.b.	2.24	2.24	2.29

LIME—Warehouse prices, New York quotes 280 lb. net; Chicago, 180 lb.:

	Hydrated, per Ton—Finishing	Hydrated, per Ton—Common	Lump, per Barrel—Finishing	Lump, per Barrel—Common
New York	$18.20	$11.00	$3.50	$2.10@$3.00
Chicago	20.00	18.00	....	1.50

LINSEED OIL—These prices are per gallon:

	New York—Current	New York—One Year Ago	Chicago—Current	Chicago—One Year Ago
Raw in barrel (5 bbl. lots)	$0.85½	$0.84	$0.85	$0.87

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry—Current	Dry—1 Yr. Ago	In Oil—Current	In Oil—1 Yr. Ago
Red	15.25	15.25	16.75	16.75
White	15.25	15.25	15.25	15.25

HOSE—Quotations at New York warehouses:

Fire Protection, 50-Ft. Lengths
Underwriters' 2½-in. coupled, single jacket (net) ..... $0.68 per ft.

Air—Best Grade
¼-in., per ft. ..... 3 ply $0.34 4 ply $0.42

Steam—Discounts from List
First grade .... 40% Second grade ..... 40–5% Third grade 50%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. for rubber transmission belting.
Best grade ..... 50% Second grade 50–10%

LEATHER BELTING—List price, 24c. per lin.ft. per inch of width for single ply at New York warehouses:

Grade	Discount from list
Medium	40–5%
Heavy	30–10%

RAWHIDE LACING
For cut, best grade, 50%, 2nd grade, 60%.
For laces in sides, best, 41c. per sq.ft.; 2nd, 37c.
Semi-tanned: cut, 50%; sides, 41c. per sq.ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam, ¼ in.	$0.95
Rubber sheet	.50
Rubber sheet, wire insertion	.80

MANILA ROPE—Per lb., ¼-in. and larger, 1,200-ft. coils.

Atlanta	$0.27	New Orleans	$0.21
New York	.24½	Seattle	.23
Chicago	23½	San Francisco	.22½

EXPLOSIVES—Prices per pound of dynamite in small lots:

	Gelatin—40%	Gelatin—60%
New York	$0.265	$0.2875
Minneapolis	.1917	.2123
Denver	.2025	.2275
Seattle	.165	.19
Cincinnati	.22	.245
San Francisco	.1625	.1925

FLOTATION OIL—Pine tar, 50 gal. bbl., gross weight 500 lb., f.o.b. New York, carload lots, per gal. $0.41

CHEMICALS—Prices f.o.b. producing point, per lb.:

Zinc dust, 550 lb. casks	$0.10½@.11
Litharge, casks	.10
Sodium cyanide, 220 lb. single case lots	.18@.22
Calcium carbide, in drums	.05½@.06

Mining Stocks—Week Ended April 23, 1927

Stock	Exch.	High	Low	Last	Last Div.
COPPER					
Anaconda	New York	48	46½	48	Ap.16,May21 Q 0.75
Arcadian Consol.	Boston	*40	*40	*40	
Ariz. Com'l.	Boston	7½	6¾	7½	Ja. 7, Ja. 28 0.50
Calaveras	N. Y. Curb	2⅛	1 1/16	2⅛	
Calumet & Arizona	New York	70	66½	69½	Ma. 5, Ma. 21Q 1.50
Calumet & Hecla	Boston	17	16½	16½	My.31, Jn.15Q 0.50
Cerro de Pasco	New York	63½	61½	62½	Ap. 14, My.2 Q 1.00
Chile Copper	New York	38⅜	36⅞	37⅜	Ma.4,Apr.1, Q 0.62½
Con. Coppermines	N. Y. Curb	3⅛	3	3⅛	
Copper Range	Boston	13⅛	12½	13	Ap.2, My 2, A 1.00
Crystal Copper	Boston Curb	*27	*26	*26	
East Butte	Boston	2⅛	2	2	Dec., 1919 0.50
Granby Consol.	New York	39⅜	35	39⅜	May, 1919 1.25
Greene-Cananea	New York	45⅝	40⅛	42⅞	Nov., 1920 0.50
Hancock	Boston	*32	*32	*32	
Howe Sound	New York	41⅞	39½	39⅜	Apr.1,Apr.15 Q 1.00
Inspiration Consl.	New York	20½	18½	19⅞	Ma.17, Ap.4,Q 0.25
Iron Cap	Boston Curb			2	
Isle Royale	Boston	11	10½	11	Fe.4, Fe.19 Q 0.50
Kennecott	New York	66⅜	63⅞	65⅞	Mar. 4 Apr. 1 Q 1.25
Magma Copper	New York	35⅛	34⅜	34⅜	Ma.31,Ap.15,Q 0.75
Mason Valley	N. Y. Curb	1⅜	1⅛	1⅜	
Miami Copper	New York	16⅛	15⅝	15⅞	My.2,My.16 Q 0.37½
Mohawk	Boston	41⅛	39⅜	40⅜	Ap.30, Jn.1 Q 1.00
Mother Lode Coa.	New York	4⅛	4⅛	4⅛	De.10, De.31SA 0.37½
Nevada Consol.	New York	14⅞	14⅜	14⅝	Ma.17,Ma.31Q 0.37½
New Cornelia	Boston	22⅝	22⅛	22½	My.6, My.23Q 0.50
Noranda	N. Y. Curb	22⅛	20⅞	22⅛	
North Butte	Boston	2⅛	1⅞	2	Oct., 1918 0.25
Ohio Copper	N. Y. Curb	*60	*43	*59	Sept., 1926 0.03
Old Dominion	Boston	14⅛	13	14	Dec., 1918 1.00
Phelps Dodge	N. Y. Curb	120½	120	120	Ma.22, Apr.2 Q 1.50
Quincy	Boston	19⅛	15⅞	18	Mar., 1926 1.00
Ray Consolidated	New York	15⅛	15	15⅛	Ap.20, Ap 30 0.25
St. Mary's Min. Ld.	Boston	23⅛	21⅛	23	Fe.10 Ma.10 2.00
Seneca Copper	New York	2⅜	2⅛	2⅛	
Shattuck-Denn	Boston Curb	5⅛	4⅞	5	
Tenn. C. & C.	New York	13	11⅞	12⅛	Fe.28, Ma.15, Q 0.25
United Verde Ex.	N. Y. Curb	24½	23½	24¼	Apr.6, May1 Q 0.75
Utah Copper	New York	115⅛	113½	115½	Ma.17,Ma.31Q 1.50
Utah Metal & T.	Boston	1 1/16	1	1 1/16	Dec., 1917 0.30
Walker Mining	Salt Lake	*64	*52	*52	
NICKEL-COPPER					
Internat. Nickel	New York	59⅞	51	59½	Ma.17,Ma.31Q 0.50
Internat. Nickel, pfd.	New York	...	...	105	Ap.14,My.2 Q 1.50
LEAD					
Gladstone Mtn.	Spokane	*25⅜	*25	*25½	April, 1927 0 005
National Lead	New York	199	192	195½	Jn.10,Jn.30 Q 1.25
National Lead pfd.	New York	130	126	129½	My.10,Jn.15Q 1.75
St. Joseph Lead	New York	40⅞	40	40	Se.10,Se.20, QX 0.75
ZINC					
Am. Z. L. & S.	New York	8½	8⅛	8⅛	May, 1917 1.00
Am. Z. L. & S, pfd.	New York	48½	47	47	Nov., 1920 1.50
Butte C. & Z.	New York	4⅛	3⅞	4⅛	De.9, De.24 0.50
Butte & Superior	New York	10⅛	9⅛	9⅜	Ma.15, Ma.31Q 0.50
Callahan Zn-Ld.	New York	1⅞	1⅝	1⅝	Dec., 1920 0.50
Consol. Lead&Zinc'A'	St. Louis	15	14⅛	14⅜	Ma.15, Ap.1 Q 0.25
Eagle-Picher	Cincinnati	27½	26½	26⅝	Au.15, Se.1 Q 0.40
Eagle-Picher, pfd.	Cincinnati	116	116	116	Jn.30, Jy.15 Q 1.50
New Jersey Zn.	N. Y. Curb	189	187	189	Ja.20, Fe.10 Q 2.00
United Zinc	N. Y. Curb			55	
Yellow Pine	Los Angeles	*25	*25	*25	Dec. 1925 Q 0.04
GOLD					
Alaska Juneau	New York	1⅛	1⅛	1⅛	
Argonaut	Toronto	*43	*40½	*42½	
Barry-Hollinger	Toronto	*45	*40	*45	
Carson Hill	Boston	*40	*40	*40	
Consol. W. Dome L.	Toronto	*7⅛	*7⅛	*7⅛	
Cresson Consol. G.	N. Y. Curb	2	2	2	Ma.31,Ap.10Q 0.10
Dome Mines	New York	8⅛	7⅜	8⅛	Ap.18, My5.Q 0.25
Golden Cycle	Colo. Springs	†1.70	†1.68	...	Fe.28,Ma. 10 Q 0.04
Hollinger Consol.	Toronto	20 85	20 70	20 80	Ap.6, Ap.20 0.10
Homestake Mining	New York	62	61½	61½	Ap.20,Ap.25 M 0.50
Kirkland Lake	Toronto	1.26	1.16	1.17	
Lake Shore	Toronto	19.40	19 05	19.15	Ma.1, Ma.15 0.10
McIntyre-Porcupine	New York	26	25⅜	26	My.2, Jn.1 Q 0.25
Portland	Colo Springs	†*50	†*47	....	Ap.6, Ap.15, Q 0.02
Rand Mines	New York	....	....	9⅛	Au.23–30Am.Sh. 1.52
Teck-Hughes	Toronto	7.14	6.90	7.00	Ja.31, Fe. 1 0.05
Tom Reed	Los Angeles	*50	*50	*50	Dec., 1926 0.02
Tough-Oakes	Toronto	*55	*51	*51	
United Eastern	N. Y. Curb	...	...	*44	July, 1924 0.05
Vipond Cons.	Toronto	1.45	1.40	1.40	Apr.1 Apr.15 0.03
Wright-Hargreaves	Toronto	11.20	11.05	11.14	Ap.15,My.2 0.10
GOLD AND SILVER					
Carnegie Metals	Pittsburgh	...	...	*13	
Con. Cortez	N. Y. Curb	*23	*20	*23	
Con. Virginia	San Francisco	*5⅛	*4⅛	*4⅛	
Dolores Esperanza	N. Y. Curb	*45	*38	*45	July, 1923 0.05
Premier Gold	N. Y. Curb	2⅛	2 1/16	2⅛	Ma.15, Ap.4Q 0.08
Tonopah Belmont	N. Y. Curb	1 1/16	1 1/16	1 1/16	Ma.15, Ap.4 0.08
Tonopah Extension	N. Y. Curb	...	...	*32	Apr. 1925 0.05
Tonopah Mining	N. Y. Curb	2⅜	2⅛	2⅛	Ma.31, Apr.21 0.07½
West End Consol.	N. Y. Curb	*13	*8	*10	Mar., 1923 0.05
Yukon Gold	N. Y. Curb	...	...	*45	June, 1918 0.02
SILVER					
Beaver Consol.	Toronto	*94	*89	*91	May. 1926 0.03
Canadian Lorrain	Toronto	*27½	*25½	*26½	
Castle-Trethewey	Toronto	1.00	*95½	*96½	
Coniagas	Toronto	3.75	3.60	3.60	May. 1924 0.12½
Keeley	Toronto	1.45	1.41	1.42	Fe. 28, Ma.15X 0.12
Lorrain Trout Lake	Toronto	....	....	*35	July, 1925 0.05
McKinley-Dar.-Sav.	Toronto	*15	*14	*14	Oct., 1920 0 03

Stock	Exch.	High	Low	Last	Last Div.
SILVER—(Continued)					
Mining Corp. Can.	Toronto	3.64	3.40	3.50	De.30, Ja.15 0.12½
Nipissing	N. Y. Curb	8	7⅞	7⅞	Ma.31, Ap.20 Q 0.15
SILVER-LEAD					
Ahumada	New York	4⅛	3⅞	3⅞	Ma 25,Ap 4,QX 0 12½
Bingham Mines	Boston	49	46¾	47⅞	Ma.21, Ap.5 Q 1.00
Bunker Hill&Sullivan	N. Y. Curb	78	75½	75½	Ma.31,Ap.4MX 0.75
Cardiff M. & M.	Salt Lake	*60	*49	*50	Feb. 5, 1927 0.10
Chief Consol.	Salt Lake	2.60	2.50	2.50	Oc.10, No.1 Q 0.10
Consti'n Mng.&Mill'g	Spokane	*30	*25	*28	
Erupcion	Boston Curb	*60	*50	*55	Ma.25, Ap.2 Q 0 07½
Eureka Lily	Salt Lake	1.42½	1.30	1.30	
Federal M. & S.	New York	118	112	112	
Federal M. & S., pfd.	New York	96⅜	94⅛	95	Fe.24, Ma.15 Q 1.75
Hawthorne Mines	N. Y. Curb	*5	*4	*5	
Hecla Mining	N. Y. Curb	13⅛	13¼	13⅛	Fe.15,Ma.15 Q 0.25
Highland-Surprise	Spokane	*9	*8	*8	
Iron King Mining	Salt Lake	*38	*38	*38	
Keystone Mining	Salt Lake			*32	Au.12, Au.26 0.07½
Lucky Jim	Spokane	*20½	*19½	*19¼	
Lucky Tiger-Com.	Kansas City	†7.00	†6 75	....	Ap.20, 1927 M 0.05
Mammoth Mining	Salt Lake	2.15	2.00	2.00	De.17, De.23,Q 0.25
Marsh Mines	Spokane	2.00	1.87½	1.87½	
North Lily	Salt Lake	3.00	2.85	2.85	
Park Utah	New York	7	7	7	Ma.15, Ap.1 Q 0.20
Plutus Mining	Salt Lake	...	...	2.00	Ja.10, J .15 Q 0.10
San Rafael	San Francisco	...	...	*24	
Silver King Coal.	Salt Lake	7.90	7.90	7.90	Ma.21, Ap.1 Q 0.25
Silversmith	Spokane	*33½	*32½	*32½	Oc.1, Oc.10 Q 0.02
Strattons Mines	Spokane	*46	*45	*45	
Sunshine M. Co.	Spokane	6.60	5.75	6.60	
Tamarack-Custer	Spokane	*30½	*30	*30	Sept., 1924 0.25
Tintic Standard	Salt Lake	11.00	11.00	11 00	Ma.16, Ma.29X 0.40
Utah-Apex	Boston	6⅛	6	6⅛	Oct., 1926 0.25
IRON					
Bethlehem Steel	New York	53⅞	50⅜	51⅜	July, 1924 1.25
Cleveland-Cliffs Iron	Cleveland	78	75	77½	Ja.15, Ja.25 Q 1.00
Colorado Fuel & Iron	New York	84⅛	76⅜	80⅜	May, 1921 0.75
Gt. North'n Iron Ore	New York	21⅛	20	20	Dec.6, Dec.28 0.75
Inland Steel	New York	47	44	45	Fe. 15, Ma.1 Q 0.62½
Replogle Steel	New York	10⅛	10	10	
Republic I. & S.	New York	71¼	65	66¼	My.14 Jn. 1 Q 1.00
Republic I. & S. pfd.	New York	104	104	104	Jn.14, Jy.1 Q 1.75
Sloss-Sheffield S. & I.	New York	130	130	130	Ma.10, Ma.21 Q 1.50
Sloss-Shef. S.&I. pfd.	New York	....	....	108½	Ma 21, Ap.1 Q 1.75
U. S. Steel	New York	172⅛	170½	172⅜	Fe.28,Ma.30 Q 1.75
U. S. Steel pfd.	New York	124⅜	122⅜	124⅛	Ja.29, Fe.26,Q 1.75
Virginia I. C. & C.	New York	...	...	44	Jan., 1924 1.50
Virginia I.C.&C.pfd.	New York	...	...	60½	De.15, Ja.2, 2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN					
De Beers Consol.	New York	31⅛	31⅛	31⅛	Ja.26, Ja.29 1.45
So. Am. Gold & P.	N. Y. Curb	3½	3½	3½	
Alum.Co.of Amer.	N.Y.Curb	70⅜	69	70	
Alum. Co. of Amerpf.	N.Y.Curb	104½	103⅜	104	Ma.15,Ap.1 Q 1.50
Vanadium Corp.	New York	50½	47¾	50	My.2, My.16Q 0.75
Patino M. & E.	New York	24⅛	22¼	23½	Ap.27, My.5 1 sh.
ASBESTOS					
Asbestos Corp.	Montreal	23	22	22½	Jan., 1926 1.50
Asbestos Corp., pfd.	Montreal	88	87	87½	Ma.31,Ap.15 Q 1.75
SULPHUR					
Freeport Texas	New York	68⅜	62	63½	Ap.15, My 2 Q 1.00
Texas Gulf, new	New York	62⅜	59⅛	59⅜	Ma.1, Ma.15Q 1.00
MINING, SMELTING, REFINING AND GENERAL					
Amer. Metal	New York	43½	41⅛	43	Fe.18, Ma. 1 Q 0.75
Amer. Metal pfd.	New York	....	....	110½	Fe.19, Ma.1 Q 1.75
Amer. Sm. & Ref.	New York	153½	147½	150	Ap.14, My.2 Q 2.00
Amer. Sm.&Ref.pfd.	New York	125½	123½	125½	My.6, Jn.1 Q 1.75
Consol. M. & S.	Montreal	260	257	257	De.31, Ja.15 X 6.25
Federated Metals	N. Y. Curb	12	12	12	
Newmont Mining	N. Y. Curb	76	74½	74¾	Ma.31 Ap.15 Q 0.60
U. S. Sm. R. & M.	New York	39⅛	37½	37½	Ap.7 Ap.15 Q 0.87½
U. S. Sm. R.&M.pfd.	New York	48⅛	47½	48⅛	Ap.7, Ap. 15, Q 0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi annually. M, Monthly. F, four weeks. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.: Spokane, Pohlman Investment Co.; Salt Lake, J. A. Hogle & Co.; Colorado Springs, Colo., Henry Sachs.

LONDON QUOTATIONS—WEEK ENDED APRIL 12, 1927

Name	High	Low	Last	Last Div. Date	Amount
Aramayo Mines (25 frs.)	85/7½	84/4½	85/—	Feb. 1927	5 (†)
British Platinum (£1)	4/4½	3/6	4/—	Feb. 1925	2½ p.c.
Burma Corpn. (10 rupees)	14/3	13/9	14/—	Feb. 1927	6 annas*
Bwana M'Kubwa (5s)	6/3	6/—	6/3		
Camp Bird (2s)	4/9	4/7½	4/9		
El Oro (£1)	4/6	4/1½	4/4½	Nov. 1924	2½ p.c.*
Esperanza (10s)	—/2	—/2	—/2		
Frontino & Bolivia (£1)	12/6	12/—	12/6	Jan. 1927	5 p.c.
Mexican Corpn. (£1)	9/6	8/—	9/3		
Mexico Mines of El Oro (£1)	16/3	15/1½	16/3	Dec. 1926	3¾ p.c.*
N'Changa Copper Mining	11/10½	10/—	10/—		
Oroville Dredging (€1)	6/9	6/6	6/9	Dec. 1923	3¾ p.c.
Ouro Preto (£1)	2/1½	2/—	2/—	May 1925	2½ p.c.
Rhodesian Congo Border (£1)	62/6	53/9	57/6		
St. John del Rey (£1)	12/6	12/1½	12/6	May 1927	3¾ p.c.
San Francisco Mines (10s)	32/4½	30 —	32/3	Jan. 1927	25s.
Santa Gertrudis (£1)	15/3	14/10½	15/—	Jan. 1927	3¾ p.c.
Selukwe (2s. 6d.)	10/7½	10.—	10/3	April 1917	6¼ p.c.
S. Amer. Copper (2s.)	3/3	3/—	3/3	Nov. 1917	75 p.c.
Tanganyika (£1)	62/—	48/3	51/3	Aug. 1926	7½ p.c.
Union Miniere du Haut-Katanga (Brussels)	9.260	9.150	9.150	July 1926	175 (‡)

* Free of British income tax. † Swiss frs. ‡ Belgian frs. and free of taxation.

New Machinery and Inventions

New Type of Level Is Both Rapid and Accurate

An ingenious type of level, which has been named the "Auto-Set," has recently been perfected by Messrs. E. R. Watts and Son, Ltd., 123 Camberwell Road, London, S.E.5, England. The distinguishing feature of this instrument is the fact that, once it has been rough leveled, the final adjustment involves no motion of the leveling bubble or of the telescope, as this is effected by tilting the line of sight up or down by simple optical means. As a result, in making the final adjustment, no trouble is experienced from the oscillation of the leveling bubble.

In Fig. 1 the newly designed instrument is shown set up ready for operation, and Fig. 2 presents a diagrammatic cross-section of the telescope. In this illustration, *D* is a diaphragm upon which are engraved a pair of cross-lines. The parallel plate refractor, represented by *G*, is mounted on an axis transverse to that of the telescope. It can be tilted in either direction by means of the wedge *W*. This wedge, through the fine adjustment, moves horizontally in either direction under the toe of the lever *L* which is mounted on the axis of the glass plate *G*.

The spirit level is of the constant-bubble-length type. Tests show that the length of this bubble remains constant throughout a range extending from below 0 deg. F. to above the highest tropical temperature. Therefore, it is only necessary to read one end of the bubble, which can be done from the eye end of the instrument by means of the prism *P*. This prism moves with the wedge and has a cross-line engraved on its lower face at *X*. The bubble is lighted from below by a reflector and the position of the prism is adjusted until *X* and the end of the bubble *B* are seen to coincide. It then appears to the eye as indicated in the small drawing in Fig. 2. The "anti-parallax pointers," *YY*, are engraved on the vertical face of the prism and the line *X* on its horizontal face.

When coincidence is obtained the line of sight is truly level although the geometric axis of the telescope may not be exactly horizontal. The bubble range is sufficient to allow for a fine adjustment of ± 4 minutes. Rough leveling, to this degree of refinement, is easily effected by the hand lever shown pendant below the instrument in Fig. 1.

The top of the instrument stand has the form of a hollow cup with a spherical interior surface. The telescope is mounted on a second cup, fitting into the first and to which it can be clamped by giving the milled head (shown at the lower end of the rod in Fig. 1) one-eighth of a turn. Rough leveling is effected by moving this rod, as required, to bring into a central position the bubble of a small spherical level which is mounted under the magnifying prism shown on the right of the telescope tube in Fig. 1. By means of a reflector, this bubble is also lighted from below and is viewed from the eye end of the instrument.

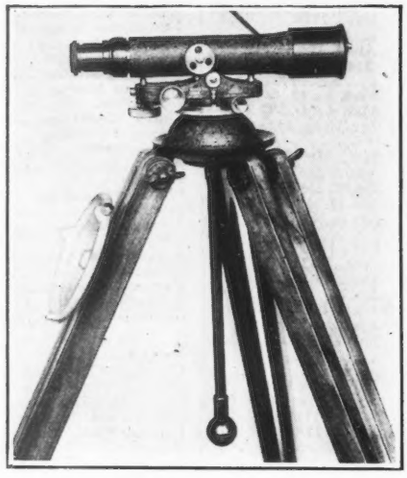


Fig. 1—Level is ready for use

In setting up the instrument, therefore, it is first necessary to center this bubble by manipulating the hanging rod previously described. When this is done, the two cups are clamped together by giving the rod one-eighth of a turn. The final adjustment is then made by turning the milled head shown near the prism in Fig. 1. This operation moves the slide *S* shown in Fig. 2 either backward or forward. On this slide are mounted the prism *P* and the wedge *W*. The motion of this wedge, as already explained, tilts the line of sight without moving the telescope. The latter can be swung in azimuth to any desired position, and can then be clamped firmly to its base. When the instrument is not in use, the spherical cup forming the head of the stand is protected by a cover of light-weight alloy. This also serves as a base for the instrument should it be necessary to set it up on a wall.

In fairly clear weather levels can be taken with this instrument to an accuracy of .01 ft. in 500-600 ft. Thus, it is equal in optical performance to the best 10-in. and 12-in. dumpy levels, yet has the decided advantage of being about three times as rapid in its operation. Level readings in many cases may be taken in from 15 to 20 seconds after the time of setting up the tripod and the average reading time, as determined by several months use on a hydroelectric construction operation, was about 30 seconds. On this same operation, a closing accuracy of .005 ft. in 2,000 ft. was obtained with moderately long sights. With short sights, in rough country and working against time, the average accuracy was .04 ft. per mile.

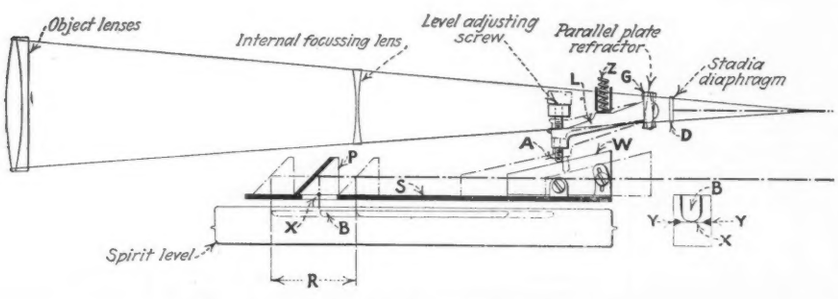


Fig. 2—Details of "Auto-Set" construction

New Single Reduction Gear Units Are Developed

The R. D. Nuttall Co., Pittsburgh, Pa., has just developed and placed on the market a series of reduction gear units for heavy service. There are six units in the series covering a range from 150 to 2,000 hp. They are designed for services that require transmitting heavy loads at relatively high speeds, such as main and auxiliary drives in steel mills, the driving of crushers, hoists, pumps and other similar heavy equipment.

These units are equipped with either Nuttall 7½ deg. single helical or Nuttall herringbone gears, treated or untreated, depending on application. They are furnished as desired with either sleeve or Timken tapered roller bearings. It is possible to replace one type of bearings with the other because the bearing housings are identical in both types. However, in case of a change new shafts would have to be provided.

The gears are totally inclosed in a cast-iron case so fabricated as to lessen the weight. Thus, they are carefully protected from grit and dirt. The bottom of the case serves as a reservoir for lubricant and the gears run in a bath of oil while the bearings are lubricated by a positive splash system. The same lubricant is used for both gears and bearings. The bottom of the case serves as a reservoir for lubricant.

Dings Wins Patent

An injunction decreed by the U. S. District Court of the Eastern District of Wisconsin in favor of the Dings Magnetic Separator Co., of Milwaukee, was affirmed by the U. S. Court of Appeals in a decision handed down on Jan. 18, without modification.

This injunction restrains a competitor from building ventilated magnetic pulleys which infringe patent No. 1,369,516 and is the result of an action brought by the Dings company against a manufacturer of magnetic pulleys. The suit which has now been decided in favor of the Dings company establishes the fact that this company is the owner of the patent on ventilated pulleys and that others offering that construction are infringing.